ATER and RELATED LAND RESOURCES
UMBOLDT RIVER BASIN
NEVADA

REPORT NUMBER TWO

PINE VALLEY SUB-BASIN

JUNE 1962

Based on a Cooperative Survey

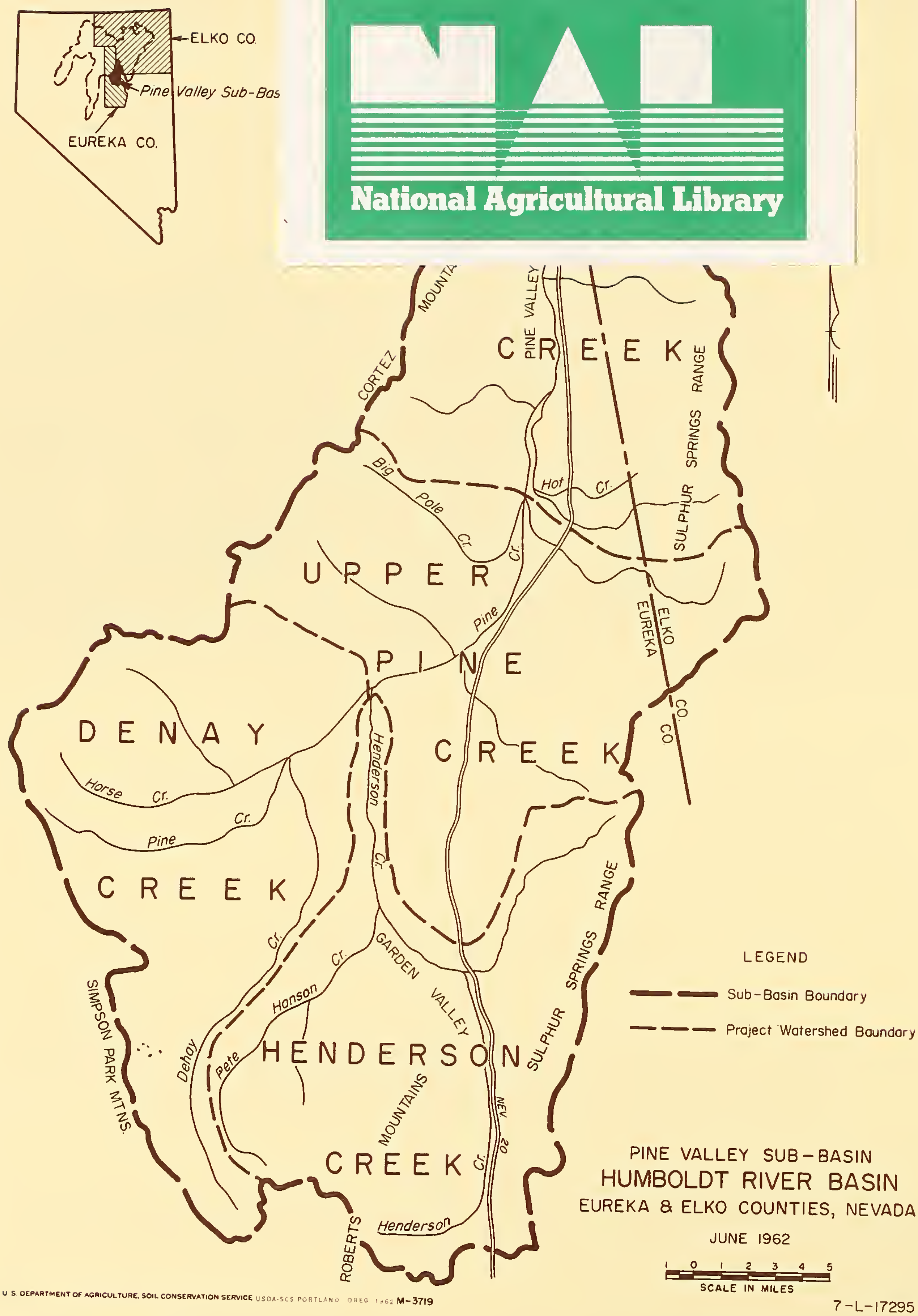
by

THE NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
***and* THE UNITED STATES DEPARTMENT OF AGRICULTURE**

Prepared by

Economic Research Service - Forest Service - Soil Conservation Service

cc: Beattie



PINE VALLEY SUB-BASIN
HUMBOLDT RIVER BASIN
EUREKA & ELKO COUNTIES, NEVADA
JUNE 1962

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FOREWORD

This is a report for the people of Nevada, and particularly for the people of the Humboldt River Basin, concerning water and related land resources in the Pine Valley Sub-Basin. It is the second of a series of reports which will result from a cooperative survey of the Humboldt River Basin by the Nevada State Department of Conservation and Natural Resources and the U.S. Department of Agriculture. It was prepared by the Soil Conservation Service, the Forest Service and the Economic Research Service of that Department.

The State of Nevada seeks constantly to assist local people and their organizations in the conservation, development and management of water resources. It has particular regard for the relationship of water to land and to human resources. This is exemplified by the creation of the Nevada State Department of Conservation and Natural Resources. A primary responsibility of that Department is to cooperate with Federal agencies and local groups and to coordinate State-Federal activities that help solve water and related land problems for the people of Nevada.

The responsibilities of the Nevada State Department of Conservation and Natural Resources, and the cooperative research work already under way in the Humboldt River, set the stage for Federal-State cooperation in developing information on opportunities for improving the use of the land and water resources of the Basin. Accordingly, cooperation was initiated with the U.S. Department of Agriculture under a Plan of Work dated June 3, 1960 with agencies of the Department and of the State of Nevada participating in the survey. It is important here to point out that responsibility for matters concerning State water rights and determination of water supply as it might affect State water rights was assumed by the State of Nevada.

This survey of the Humboldt River Basin is for the primary purpose of determining where improvements in the use of water and related land resources, some of which have social and economic aspects, might be made with the assistance of projects and programs of the U.S. Department of Agriculture. A major part of the survey is focused on situations where improvements might be brought about by means of Federal-State-local cooperative projects developed under the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress as amended). This cooperative survey is in keeping with long established tradition in the Department of Agriculture of cooperation with states and local entities in the conduct of its work. Further, such cooperation is a most important responsibility of the Nevada State Department of Conservation and Natural Resources.

The U.S. Department of Agriculture-State of Nevada Plan of Work in the Humboldt River Basin offers opportunities for participating in the survey by other Nevada State agencies and Federal agencies. The Bureau of Land Management, as an example, has cooperated with respect to the national land reserve. Thus, the survey is not limited but is rather as broad in scope and agency participation as is required to meet the agreed upon objectives.

The entire Humboldt River Basin is being studied by segments identified as sub-basins. This report contains much information for study and use in understanding and solving some of the existing water and land resource problems in Pine Valley. The report presents opportunities for Federal-State-local pr oject-type developments under the Watershed Protection and Flood Prevention Act, together with other opportunities for development and adjustment.

I wish to recognize the excellent work of the U.S. Department of Agriculture and the Nevada State Department of Conservation and Natural Resources in this cooperative effort. I consider that this report will serve the best interest of the people in the Humboldt River Basin and the State of Nevada.

Grant Sawyer

Governor of Nevada

HUMBOLDT RIVER BASIN SURVEY

PINE VALLEY SUB-BASIN REPORT

CONTENTS

TABLES

FIGURES

PHOTOGRAPHS

ORGANIZATION OF REPORT

The report on the Pine Valley Sub-Basin is divided into three main sections. The first section is an overall report on the sub-basin; the remaining two sections consist of Appendix I and Appendix II, respectively.

Appendix I is attached to all the report copies, and contains pertinent textual matter concerning the sub-basin which is of value to the general reader.

Appendix II is produced in a relatively limited number of copies. Its small appeal to the general reader renders it unsuitable for inclusion with the report copies for general distribution. However, this type of material does have potential value as an information reservoir for technicians, administrators, and resource managers concerned with the Pine Valley Sub-Basin. Copies of this appendix are available upon request.

SUMMARY

Pine Valley is a northward-draining tributary to the Humboldt River south of Palisade, Nevada. It lies mostly in north central Eureka County, but includes a narrow area in southwestern Elko County. The pear-shaped sub-basin comprises approximately 1,029 square miles of semiarid land bounded by relatively low mountain ranges. The basin is drained by Pine Creek and its principal tributaries: Hot, Horse, Denay, and Henderson Creeks. Elevations vary from about 4,840 feet at the Humboldt River to over 10,000 feet in the Roberts Mountains. Average annual precipitation ranges from 8.6 inches along the valley floor to about 18 inches in the high mountains. The frost-free period is estimated to average 125 days (28°F) in the valley. At present there are no existing or authorized Federal projects for flood control or irrigation water development in the sub-basin.

Pine Valley is a sparsely populated rural area. The 1960 population of Palisade Township was 186, an average population density of about 0.18 persons per square mile, virtually all of whom are engaged in livestock production or related work. Carlin, near the northern terminus of the sub-basin, had a 1960 population of 1,023.

The dominant agricultural activity in the basin is raising livestock. Approximately 5,600 acres of land are or have been devoted to raising meadow hay and alfalfa for fall and winter forage for livestock. Licenses are issued by the Bureau of Land Management to provide spring and summer range on approximately 538,600 acres of Federal lands for domestic livestock, with some fall-winter use. In many instances exchange-of-use permits are granted the owners of private intermingled lands; these areas are then administered with the Federal lands by the Bureau of Land Management. The high mountain lands also function as the principal water-yielding areas, and are becoming increasingly important for recreation use. Private and State-owned lands which are primarily used as range for grazing livestock total 110,100 acres.

Surface irrigation water supplies are provided primarily from spring snow-melt and rainfall, which usually occur from February through May. These supplies are supplemented by springs, return flow from ground water, and pumped wells. The computed gross water yield for the basin was about 20,000 acre-feet, based on an 80 percent frequency, and about 23,000 acre-feet for a 50 percent frequency. The area is subject to wide fluctuations in annual gross water yield, varying from a low of 16,000 acre-feet in 1931 to about 50,000 acre-feet in 1910. Results of limited well water tests indicate that the water quality is poor, and not generally suitable for irrigation. Irrigation development in the valley is limited, consisting of a small acreage of land leveling, diversion structures, spreader ditches, and irrigation wells. Irrigation is principally by an extensive type of wild flooding, with limited use of such methods as corrugations, borders, and sprinklers.

Water rights were established by the George A. Bartlett Decree of 1931. All rights which were set forth in this decree are for land in the north end of the valley, from the Humboldt River south through the Slagowski Ranch. Water is allocated to users on the basis of priority of right. In general, the decree provides for a flow of 1.25 cubic feet per second per 100 acres of land, or at rates proportional to this. When water is available, the delivery rate is as follows:

Class A right, 4/15 to 8/15, 3 acre-feet per acre, for 3,431 acres

Class B right, 4/15 to 6/15, 1.5 acre-feet per acre, for 182 acres
Class C right, 4/15 to 5/15, .75 acre-feet per acre, for 304 acres

Shallow ground water is a significant source of water for meadow hay and pasture production. The Field Party estimated that 2,400 acre-feet of ground water are used by irrigated crops and 10,450 acre-feet are used by various phreatophytic plants of both high and low economic value, growing on 30,170 acres.

Of the 648,900 acres of range land, 496,700 acres, or 76 percent, are considered as low forage production range; 117,600 acres are medium forage production range; and only 24,600 acres are fairly high forage production range. Four fires have burned 23,846 acres of range forage since 1947; three of these occurred in 1957.

Since 1874 there have been 14 flood years which caused damage in the sub-basin. All these floods have caused some measure of damage in the form of watershed erosion, sedimentation on cropland, and stream and gully erosion. A few of the larger floods damaged roads, bridges and ranch buildings. These large floods caused severe damage to the local railroad before it was finally abandoned in 1938.

Regular Department of Agriculture and other Federal and State programs can provide assistance in improving or accomplishing many needed improvements in the sub-basin. In its regular program, the Bureau of Land Management is installing range, recreation, and watershed improvements on the Federal lands that agency administers.

An opportunity for project development was evaluated which considered the entire sub-basin as interdependent watersheds, the plans for which would need to be developed concurrently. Under this proposal, whose primary purpose would be the conservation and development of the water resources, the following measures would be needed:

Installation of:

1. Erosion control and grade stabilization structures on lower Pine Creek.
2. Division of the range into allotments and management units, with the necessary fencing and stockwater developments.
3. Plowing and seeding of suitable range sites.
4. Sagebrush spraying on selected locations.

The foregoing proposals would be justified by subsequent benefits, such as:

1. Preventing the loss of hay meadows by erosion (from headcutting and meadow desiccation).
2. Reduction of the sediment load carried downstream in Pine Creek and the Humboldt River.
3. Maintaining a balance between the interdependent range forage production and winter hay supplies.
4. Increasing forage production, which would result from improved range management measures and the betterment of range conditions through seeding and spraying.

The total benefits from all structural and land treatment measures would be compared to the total costs. The preliminary evaluation indicated benefits in relation to costs favorable enough to warrant a more detailed study.

HUMBOLDT RIVER BASIN SURVEY

PINE VALLEY SUB-BASIN REPORT

AUTHORITY AND ORGANIZATION

The need for continually improving the conservation and use of water and related land resources has long been recognized by Federal, State, and local agencies, particularly in the western states. A recent pertinent development of this continuing interest is River Basin studies under Section 6 of Public Law 566, as amended and supplemented. In Nevada such a survey is underway by the U.S. Department of Agriculture and the Nevada State Department of Conservation and Natural Resources.

The Secretary of Agriculture is authorized under the provisions of Section 6 of the Watershed Protection and Flood Prevention Act to cooperate with other Federal and with State and local agencies in making investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs.

General direction for the U.S. Department of Agriculture in the conduct of the studies and preparation of the report was provided by a USDA Field Advisory Committee composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service. The USDA River Basin Representative served as advisor and consultant to the committee.

General direction for the State of Nevada was provided by the Director of the State Department of Conservation and Natural Resources.

A Field Party, composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service completed the field work and prepared this report.

Grateful acknowledgement is made to all individuals and other State and Federal agencies who gave their counsel and technical assistance in the preparation of this report.

GENERAL SUB-BASIN CHARACTERISTICS

Pine Valley is a northward-draining tributary to the Humboldt River south of Palisade, Nevada. It lies mostly in north central Eureka County, but includes a narrow area in southwestern Elko County. The valley is about 55 miles long and 10 miles wide near the Humboldt River, increasing to about 30 miles in width at two-thirds the distance to its southern rim. Its total area is about 658,500 acres or 1,029 square miles.

Physiographically, the area may be divided into three parts: The mountain highlands; the valley uplands; and the valley lowlands. In the mountain highlands, bedrock is exposed or lies at shallow depths. The north-trending Pinyon and Sulphur Springs Ranges, with crest elevations 7,000 to 8,000 feet above sea level, lie east of the valley. The Roberts Mountains to the south, maximum elevation 10,133 feet, and the Simpson Park Mountains to the southwest, maximum elevation 7,547 feet, separated by low, sediment covered divides, comprise the headwaters area. The curving, north-to-northeast-trending Cortez Mountains, elevation 8,000 feet at the south, decreasing northward to 6,000 feet, border the valley on the west.

The basin is drained by Pine Creek and its principal tributaries: Hot, Horse, Denay and Henderson Creeks. The channel elevations increase from 4,840 feet at the Humboldt River to about 6,800 feet near the head of Henderson Creek. The average gradient is about 25 feet per mile.

Geology

The Pinyon, Sulphur Springs, and Roberts Mountains consist of Paleozoic sedimentary rocks, principally limestone, dolomite, and quartzite. The northern part of the Simpson Park Range, from east to west, consists of about equal areas of Tertiary volcanic rock, Paleozoic sedimentary rock, and intrusive rock of late Jurassic to early Tertiary age. The eastern slopes of the Cortez Mountains are mostly of Tertiary volcanic rock. A thick sequence of interbedded sedimentary rock consisting of vitric tuff, shale, sandstone, and diatomite, and also including conglomerate and sandstone of volcanic material, lies on the volcanic rock on the lower slopes north of the latitude of Tenabo Peak. This peak and the higher part of the mountains to the northeast are of Paleozoic sedimentary rock.

The mountain ranges east and south of the valley have been uplifted along faults. The volcanic rocks and overlying sediments exposed west of the valley dip east and southeast toward the faults, forming a trough beneath the basin. Within this trough are the valley uplands, remnants of two pediment surfaces, or plains of erosion and deposition, that extend from the base of the mountains. The upper and more extensive surface has developed principally upon the partially consolidated Tertiary sedimentary rocks. This surface slopes toward the valley at about four percent, and in most places is veneered by gravel. Remnants of a lower pediment are present in the northern part of the valley. Locally, the lower hills are remnants of these surfaces.

The valley lowlands include the bottomlands along Pine Creek and the lower reaches of its principal tributaries. They vary from less than a mile to a maximum of two miles in width. The lowlands are underlain by deposits of Tertiary to Recent age.

Soils

The soils have been developed mostly from volcanic and sedimentary rock. They are predominantly Sierozems and Regosols, with lesser amounts of Browns, Alluvials, Calcisols, Chestnuts, Lithosols, Humic Gleys, and Solonetz. Generally, these soils are moderately deep to deep, stony and gravelly, medium to fine textured, and somewhat excessively to poorly drained. The Lithosols are an exception; they are shallow depth soils, and are excessively drained. (See tables 4 and 5,Appendix I.)

Precipitation

The average annual precipitation at the Rand Ranch (1957-1960) is 8.6 inches, which usually occurs from February through May. A comparison with Elko and Beowawe records for the same four year period, and the long-time records at these stations, indicates that this mean precipitation at the Rand station should be close to the long-time average. There are 24 years of complete precipitation records at Palisade which were taken between the years of 1878 and 1906. The average annual precipitation, from these records, is 8.69 inches. This station is on the Humboldt River about 12 miles north of the Rand Ranch.

There are no storage or other gages in the higher elevations of the watershed. Soil development and vegetation indicate that the higher elevations of the Roberts Mountains receive around 16 to 18 inches annually.

Growing Season

The average frost-free period at the Rand Ranch is estimated to be 125 days (28°F). This is based on a comparison between Elko, 119 days, and Beowawe, 132 days. The records at the Rand Ranch (1957-1960) cover too short a period to represent the long-term average.

General Cover Conditions

The predominant plant cover over much of the sub-basin is sagebrush-grass. Before the advent of the white man, the pristine grass understory consisted of such desirable perennial bunchgrasses as Idaho fescue (Festuca Idahoensis) and bluebunch wheatgrass (Agropyron spicatum), with small amounts of Sandberg bluegrass (Poa secunda) and the needlegrasses (Stipa spp.). A substantial amount of the cover consisted of bitterbrush (Purshia tridentate) mixed with scattered big sagebrush (Artemisia tridentata) on the higher north slopes and in the basins. (See photographs 1 and 2.)

Descriptions of Pine Valley as recorded by various early-day observers (Elko Independent, 1869-70 files) present a vastly different picture of its vegetative quantity and quality at that time, when contrasted to present conditions. It was described by one writer as being a "long, grassy, valley, with a clear, silvery stream of water running through the center". Another report stated that Pine Creek was noted for its splendid trout fishing. Still another writer described the section from Palisade to Mineral Hill as "one of the most beautiful and fertile in the State, containing a vast amount of fine meadow land". The higher mountain slopes were said to be thickly covered with bunchgrass, while white sage (Eurotia lanata, which has long since disappeared from the scene here) clothed the lower slopes and the terraces above the valley floor.

The mountain ranges on both sides of the valley, according to another report, were spread "with a thick and tangled growth of mountain mahogany, nut-pine (pinyon) and cedar wood". The mountains immediately to the east of the now deserted mining camp of Mineral Hill were described in 1870 as "dark round hills, covered with timber". Today, these same hills are practically devoid of either pine or juniper cover.

Very little of the pristine cover now remains in Pine Valley. However, from the contemporary descriptions contained in the two preceding paragraphs, as well as from the statements of old residents, and as evidenced by a few relatively inaccessible relict areas still to be found in the Cortez Range, it is certain that most of the slopes and basins above the stream-bottoms were well covered with desirable perennials. Most have now been virtually eliminated through grazing overuse, primarily from domestic livestock, although the now scattered stands of bitterbrush have been heavily used by deer in the last 25 years. Cheatgrass (Bromus tectorum) has largely replaced the perennial grasses. There are some areas of such increaser species as Sandberg bluegrass and bottlebrush squirreltail (Sitanion hystrix) on the upland benches and terraces.

Over the years, the meadows and upland grass areas, consisting primarily of Great

Photograph 1. - Sagegrush-grass type, four miles east of Buckhorn townsite, Pine Valley. Looking southeast across Horse Creek; Roberts Mountains in background.

6-606-11 FIELD PARTY PHOTO

Photograph 2. - Sagebrush-grass type, upper Henderson Creek, looking southeast from Cortez Mountain foothills. Roberts Mountains in center background.

6-590-8 FIELD PARTY PHOTO

Basin wildrye (Elymus cinereus) and some creeping wildrye (Elymus triticoides) with wet and dry meadow sedges, have decreased, probably because of the drainage of these areas by the extensive gully system which has developed along most of the sub-basin stream bottoms since 1910. These meadows have been replaced by sagebrush, or non-beneficial phreatophytes, such as rubber rabbitbrush (Chrysothamnus nauseosus) and greasewood (Sarcobatus vermiculatus). Many of the hay meadows in the lower portion of the sub-basin, north of the Slagowski Ranch, are also being invaded by these phreatophytes and by sagebrush. Saltgrass (Distichlis stricta) is found in almost pure stands or as an understory to scattered greasewood and rabbitbrush along the Pine Creek bottoms southward from the Trading Post.

The higher elevations in the Pinyon, Sulphur Springs, Simpson Park, and Roberts Mountains have extensive areas (approximately 93,000 acres) of pinyon (Pinus monophylla), juniper (Juniperus utahensis), and curl-leaf mountain mahogany (Cercocarpus ledifolius), most of which is second growth, with little or no grass or herbaceous understory. Most of the original stands of pinyon were removed during the latter third of the last century for the production of charcoal, and pinyon is now scarcely to be found on many of its former sites in the Pinyon and Sulphur Springs Ranges. When pinyon is clear cut or removed from a site in wholesale quantities, the resultant opening up of the stand allows big sagebrush, grasses and herbaceous growth, if not inhibited by too heavy grazing use, to move into the cleared areas. As this establishment of other species develops, the competition from these plants prevents the extensive regrowth of pinyon seedlings on the cleared site. Pinyon have been largely replaced by sagebrush-grass, or by juniper. The latter species was not cut for charcoal. Only at the higher elevations of the Sulphur Springs, Roberts, and Simpson Park Mountains are fairly heavy stands of pinyon still present.

In some of the higher areas, the stands of mahogany and juniper-pinyon have been taken out by large range fires within the past 10 years, notably the 8,000 acre Cottonwood fire in the Cortez Mountains, the 12,900 acre Union fire from Union Summit northward, and the 1,200 acre N.T. Springs fire south of Union Summit. These fires occurred in July 1957.

Small stringer stands of aspen (Populus tremuloides) are found along some of the stream bottoms in the Cortez Mountains: Big and Little Pole Creeks, Sheep Creek, and others. On the east side of the valley these aspen types are scarcer, being found principally at the heads of Trout Creek and Smith Creek. Aspen stringer types also occur along some of the perennial streams flowing north from the Roberts Mountains.

Water Yield

Surface irrigation water supplies are provided primarily from spring snow-melt and rainfall. These supplies are supplemented by large springs, base streamflows fed by slowly percolating ground water, and pumped wells.

The gross water yield (available water prior to irrigation and phreatophyte use) from all drainages in Pine Valley was computed for the past 52 years (1909-1960), using the 14 years of streamflow records on Pine Creek, the records of the South Fork gage near Elko, the records of the Humboldt River gage at Palisade, and from the Field Party's water balance studies. From these data the computed 80 percent frequency yield was about 20,000 acre-feet, and the median (50 percent) yield was about 23,000 acre-feet. The yield extremes varied from about 16,000 acre-feet in 1931 to about 50,000 acre-feet in 1910.

The Roberts Mountains, which are drained by Henderson Creek and its tributaries, yield the greatest amount of water (see figure 1). The group of drainages in what is referred to as the middle Pine Creek watershed has the greatest yield per acre. This area includes the Hot Springs, which have a continuous flow of four to five cubic feet per second. There are many small seeps scattered throughout the sub-basin which were not investigated for yield.

The volume of ground water storage is reported to be substantial. (See Ground Water Resources-Reconnaissance Series, Report No. 2.) From the limited number of tests made on the quality of well water, it appears doubtful that much of this can be used for irrigation. Results of analyses made on four wells (T.29N., R.52E.) indicate the water is not suitable for irrigation. The use of the water tested would result in rather rapid salinization and high exchangeable sodium concentrations in the soil after a relatively few years. Total salts in these tests ranged from 630 p.p.m. (parts per million) to 4,620 p.p.m. A well drilled at the Trading Post also was reported to be salty to taste. Another well tested showed the water to be of fair quality for irrigation use, although it too had a high sodium content.

Test holes should be drilled in areas where irrigation wells are contemplated, so that the quality and quantity of the water can be determined.

HISTORICAL INFORMATION

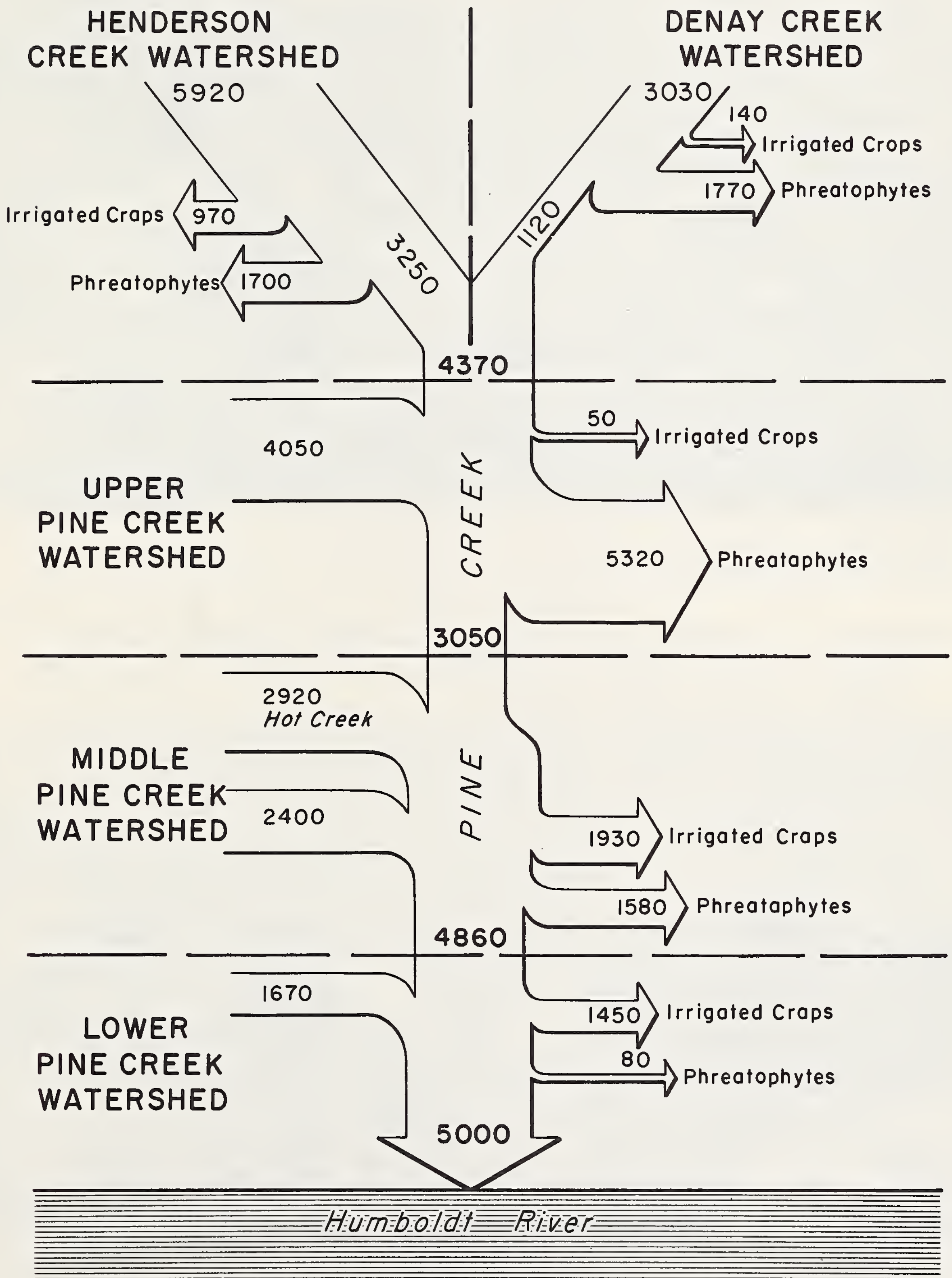
Settlement and Population

The period from 1828 to 1841 marked the earliest penetration of Pine Valley by the whites (trappers), although it still remained primarily a haunt of the Shoshone tribe during this time. During the period 1841-1868 the lower valley was occasionally traversed by emigrant parties using the Woodruff Canyon-Crescent Valley bypass of Palisade Canyon on the California Emigrant Trail along the Humboldt.

Full use of the Pine Valley grass and timber resources began with the advent of the Central Pacific Railroad along the Humboldt in late 1868. The town of Palisade was established on that line in 1870 as an outlet for the burgeoning freight traffic from the Base Range lead and silver mines at Eureka and the mines at Mineral Hill and Cortez, in Pine and Crescent Valleys. (See photograph 3.) To more adequately handle this traffic, the ninety mile Eureka and Palisade Railroad (narrow gauge) was completed through Pine Valley late in 1875. The little line was one of the Eureka-Pine Valley area's economic mainstays. It served this territory continuously until its abandonment in 1938, brought about by the final decline of Eureka ore traffic and competition from highway trucks. Its only extended break in service occurred in 1910, when almost a third of the track was washed out by the disastrous winter floods of that year; it was not repaired until 1912.

The production of hay and livestock in Pine Valley started in the early 1870's. At first the hay was grown to feed the large numbers of draft animals used on the stage and freight roads serving Palisade, Mineral Hill, Eureka, and the White Pine mines. (See photograph 4.). After the completion of the E. & P. Railroad in 1875, much of this hay was shipped out of the valley, as well as being used for the dairy ranches which flourished in the lower Pine Valley during the 1870's and 1880's. The range livestock industry, starting in the 1870's, grew rapidly until the "White Winter" of 1890, when tremendous numbers of cattle, sheep, and horses starved to death on the open ranges throughout the Humboldt Basin.

Figure 1. - Flow Diagram of Water Yields and Depletions in Acre-Feet for the Pine Valley Sub-Basin (80% Frequency).



SOURCE: HUMBOLDT RIVER BASIN FIELD PARTY

Photograph 3. - Mineral Hill, looking east, about 1907. BRUFFEY PHOTO

Photograph 4. - "Sagebrush Clipper" freight wagon with team, old Palisade-Eureka N-T freight road at Bruffey Ranch, Pine Valley, about 1905, looking west. Early-day grazing use of Pine Valley's meadows and range lands by the draft stock of the freight and staging companies was heavy. BRUFFEY PHOTO

This catastrophe brought to a sudden halt the practice of wintering large livestock herds on the open range without adequate supplemental feed.

After 1890, the livestock industry made a slow, gradual recovery. The number of ranches began to decline, paralled by a corresponding increase in ranch size as the smaller units were combined into a few large outfits; this trend has continued through the years.

At present Pine Valley is a sparsely populated rural area. The 1960 population of Palisade Township, which consists primarily of the valley, was 186, an average population density of about .18 persons per square mile. Except for a small local store and a Nevada highway maintenance station, the present population consists of ranch families and their hired help.

The local supply centers for the people in the valley are Carlin, to the north, with a population of 1,023; Elko, to the northeast, population 6,298; and Eureka, to the southeast, population 470.

Floods

In common with the rest of the Humboldt Basin, this sub-basin has been subjected to periods of flooding and of high water. The earliest flood year of record along the Humboldt River and its tributaries, including Pine Valley, was 1862.

For further information on the history of Pine Valley's floods and high water periods, the reader is referred to the flood chronology in Appendix I.

Fires

On the national land reserve lands (formerly public domain) administered by the Bureau of Land Management, four Class "E" fires (300 acres or over) have burned 23,846 acres since 1947, which was one of the first bad fire years after the institution of organized fire protection by the Grazing Service (present Bureau of Land Management). Three of these fires occurred in 1957, leaving extensive scars on the range and watershed lands in the vicinity of Union Summit and Table Mountain in the Hot Springs Range, and on Horse Creek in the Cortez Range.

PREVIOUS STUDIES

There have been no past studies made of this sub-basin from the standpoint of water use or watershed problem analysis by any Federal agency.

Cooperative Federal and State Studies

The Nevada State Department of Conservation and Natural Resources published Report Two of its ground water resources-reconnaissance series, entitled *Ground Water Appraisal of Pine Valley, Eureka and Elko Counties, Nevada* in January 1961. This appraisal was authored by Thomas Eakin, of the U.S. Geological Survey, which agency is working cooperatively with the State of Nevada in making a series of ground water reconnaissance surveys of the State. This program is designed to give information on the possibilities for the development of ground water in areas where such information is not now available.

Other Studies

An article entitled Cenozoic Geology in the Vicinity of Carlin, Nevada, by Jerome Regnier, was published in the August 1960 issue of the Bulletin of the Geological Society of America. The paper is a technical study of the strata and structure of a particular section of Cenozoic rocks in the vicinity of Carlin, Nevada, and it covers three physiographic units in that area. The northern half of Pine Valley, from approximately Hot Creek northward,is one of the units analyzed and discussed in the study.

LAND AND WATER USE

Land Status

Pine Valley has a total area of approximately 658,500 acres, of which 538,600 acres or 82 percent are national land reserve, administered by the Bureau of Land Management; 300 acres of State lands; and 119,600 acres are privately owned. Included in the private ownership are 7,800 acres owned by the railroad. Sections of Federal, railroad, and private lands are intermingled in a checkerboard pattern in the northern third of the valley. This ownership pattern was originally established by Federal grants to the Central Pacific Railroad (now Southern Pacific) of alternate sections of land in a strip 40 miles wide, the southern half of which crosses the northern third of Pine Valley. Much of the land in Pine Valley originally granted to the railroad has been subsequently purchased by individuals, further confusing the checkerboard pattern of ownership by changing from one owner, the railroad, to many owners.

The first settlers in the valley were interested in acquiring title only to the areas of meadow land, lands bordering sections of the streams with perennial flows, and small local areas containing springs and seeps. Except for the transfer of railroad lands to private individuals, the pattern of ownership established by the Federal railroad grants and the first settlers has persisted.

The lands irrigated are privately owned. The rangelands, consisting primarily of Federal lands but with intermingled railroad and private lands, are included in the Elko and Battle Mountain districts of the Bureau of Land Management.

Land Use

The national land reserve and railroad lands are used primarily as spring and summer ranges for domestic livestock, with some fall-winter use, and as year-long range for big game and other wildlife. The high mountain lands also function as the principal water yielding areas of the sub-basin, and are becoming increasingly important for recreation use. In 1960 the national land reserve lands furnished forage for approximately 41,000 AUM's of cattle, 5,400 AUM's of sheep and 2,300 AUM's of horses and burros. In many instances exchange of use permits are granted the owners of private intermingled lands and the use of these areas is then administered with public lands by the Bureau of Land Management. The bulk of current grazing on national land reserve range is common use,although a small number of individual allotments have been established and division of the range into individual allotments is progressing.

Approximately 5,600 acres of the privately owned lands are or have been used for the

production of crops. An additional 4,200 acres of pasture lands are periodically flooded when irrigation water supplies are available. The balance of the privately owned land, 109,800 acres, is used for the production of range forage. Practically all the irrigated land is used to produce winter feed for livestock. In 1960 forage crops consisted of about 5,200 acres of meadow hay and 400 acres of alfalfa. Other crops grown in the valley, primarily for ranch use, included a very small acreage of cereal grains, potatoes, vegetables and fruit. Currently there are 12 operating ranches with headquarters in the valley. Until recently there were 11, but one of these has since been divided.

The acreage of land irrigated and the acreage of cropland harvested vary widely from year to year. The acreage irrigated since 1919 has ranged from a low of 2,703 acres in 1929 to 9,829 in 1949. The acreage of cropland harvested was 5,590 in 1949. Data on cropland harvested in Pine Valley for years other than 1949 are not available. However, approximately 40 percent of the land irrigated in Eureka County is in Pine Valley, and data for the county indicate the variation in cropland harvested in the valley. In Eureka County, cropland harvested has ranged from 7,287 acres in 1934 to 21,409 in 1949.

Water Rights

Water rights in Pine Valley were established by the George A. Bartlett Decree of 1931. All the rights set forth in this decree are for land in the north end of the valley, from the Humboldt River south through the Slagowski Ranch.

In general, the decree provides for a flow of 1.25 c.f.s. per 100 acres of decreed land, or at proportional rates. When water is available class A rights are for the delivery of water at this flow rate for a period of 120 days, April 15 to August 15; or a total water delivery of three acre-feet per acre. Class B rights are for 60 days, April 15 to June 15, for a total of 1.5 acre-feet per acre. Class C rights are for 30 days, April 15 to May 15, for a total of .75 acre-feet per acre. Class A rights apply to 3,431 acres, Class B, 182 acres, and Class C, 304 acres, for a total of 3,917 acres with decreed water rights. In 1960 there were about 1,680 acres irrigated for which water rights have not been adjudicated.

Water Use

The annual water balance studies made by the Field Party show that during an 80 percent frequency flow year the water yield is used as follows:

	Acres	Water use acre feet
Irrigated crops	5,600	4,550
Phreatophytes	30,600	10,450
Out-flow	------	5,000

Surface Water

The dominant uses of water in Pine Valley are for irrigation, for livestock, and for domestic purposes. Culinary and stock water use, while of strategic importance with respect to location, quality, and availability, do not require very large quantities. Water required

annually to satisfy existing irrigation water rights, measured at the point of use, totals about 10,800 acre-feet. The surface flow available to satisfy these rights, in most years, is inadequate with respect to location, quantity available, and seasonal distribution.

There are about 5,600 acres of crop land in the sub-basin, located principally along Pine Creek, between its confluence with the Humboldt River and the Slagowski Ranch, and in Garden Valley along Henderson Creek. There also are relatively small isolated tracts of irrigated fields scattered along the perennial reaches of other streams.

The majority of the native hay lands, about 5,200 acres, receives one continuous surface irrigation during the period of high seasonal flows. The alfalfa fields, about 400 acres, and a limited acreage of native hay meadows, receive subsequent irrigations with water obtained from springs, wells, and base streamflow.

Ground Water

Shallow ground water is a significant source of water for meadow hay and pasture production (see Phreatophyte acreage and ground water use, table 2, page 45).

Water pumped from most of the wells has a high salt content. This well water is mixed with surface water to reduce salt concentration, or when of satisfactory quality is used directly to irrigate alfalfa, and also in limited amounts to irrigate meadow hay during the late spring and summer months.

Irrigation Methods

Water use and irrigation methods are dictated by the nature of the water supply and the type of agriculture of the area. There is a limited amount of irrigation development, consisting of a small acreage of land which has been leveled, diversion structures, spreader ditches, irrigation wells, and springs on an individual ranch basis. There are few irrigation developments in the valley involving more than one ranch.

Irrigation is principally by an extensive type of wild flooding. Since water supplies from surface streams vary widely, regulation of irrigation water is difficult. The application of variable streams to large acreages of low yielding meadow land does not justify spending much time per acre in irrigation; this results in low irrigation efficiency. During the snowmelt period the high streamflows spread out over the meadow and pasture lands naturally, or they are diverted from the channels by simple temporary diversion dams and spread over the land by manmade ditches and dykes. The hay and pasture forage receive part of their water needs from the ground water. Most ranchers attempt to irrigate as many acres as possible with the water available.

Limited use has been made of corrugation, border, and sprinkler irrigation on alfalfa and meadow land. Data from the 1950 Census of Irrigation indicate that 9,829 acres in Pine Valley were irrigated in 1949. Of the 18 separate irrigation enterprises listed, all were single ranch systems with an average size of 546 acres. Sixteen of the enterprises used streamflow water only. Two enterprises used both streamflow and stored water. The total cost of water per irrigated acre was reported to be four cents.

THE AGRICULTURAL INDUSTRY

Pine Valley agriculture is dominated by the range livestock industry. Currently, livestock enterprises consist almost entirely of production and sale of feeder-type cattle. Two ranches in the valley run sheep as well as cattle. Since World War II, the trend in beef enterprises seems to have been toward a cow-calf operation, wherein calves are sold rather than carried for later sale as long yearlings or two and three year olds.

Livestock on Pine Valley ranches, based upon B.L.M. licenses for fiscal year 1962, was estimated at 9,000 cattle and calves and 5,500 sheep. Major shifts in the relative numbers of cattle and sheep in the area have occurred during recent years. Sheep increased rapidly between 1910 and 1925, and have now declined to about one-sixth of their peak numbers. Between 1910 and 1930 the number of cattle and calves was reduced by about two-thirds, with most of the decrease occurring between 1925 and 1930. Between 1930 and 1940 increased precipitation and gradual recovery in general economic conditions encouraged ranchers to restock with cattle. Herds were rebuilt by 1940 and the number of cattle and calves remained fairly uniform between 1940 and 1957. Since 1957, there has been an estimated 12 percent decrease.

The national land reserve lands provide most of the spring and summer feed for the breeding herds. Limited fall and winter use of specified areas also is allowed. Of the total livestock feed required, the Federal and intermingled private rangelands provide approximately seven months of feed. The balance of feed is provided by one to two months grazing on crop aftermath and adjacent dry and irrigated pasture and three to four months on hay. The amount of hay required for wintering livestock varies considerably. It is dependent upon the amount of forage available for grazing on the fall-winter rangelands, dry pastures, irrigated pastures, crop aftermath, and the severity of the winter.

Agricultural Income

Approximately 99 percent of the gross agricultural income in Pine Valley in 1959 was derived from the sale of range livestock and livestock products, estimated to be $500,000. Value of crop sales did not exceed $5,000.

Information on net ranch income is not available for Pine Valley ranches. Data for the State reveal that net farm income amounted to 34 percent of gross income in 1959. Although the percentage of gross income that is retained as net ranch income has varied considerably, the trend has been downward over the last decade. This reflects the price-cost squeeze that is developing in agriculture and the economic pressures for increased efficiency of ranch operation.

Markets

The livestock shipped from the area constitute the only agricultural export of significance.

Cattle sold by Pine Valley ranchers are chiefly calves, long yearlings, and cull cows consigned to feed yards in the neighboring States. It is estimated that more than 80 percent

go to California, principally to feed lots in the San Joaquin Valley. Less common markets are the feed yards of southern Idaho and Oregon, with a small number going to feed yards in the west and midwest. Most of the stock are sold on the ranch to outside buyers and shipped to destination by truck at the buyer's expense.

There is no significant outshipment of grain or hay from the valley. A small acreage of grain is grown for ranch use; surplus hay is carried over for use in poor years.

Transportation

Transportation facilities available to Pine Valley ranches are adequate. Two interstate rail lines, Southern Pacific and Western Pacific, serve the area and provide daily schedules from Carlin to the West Coast and to Ogden and Salt Lake City and points east. Both railroads also offer livestock transportation service with loading facilities at Carlin.

Several common motor freight carriers maintain terminals in Elko, provide pickup and delivery service at Carlin, and interstate service to all parts of the nation. Livestock transportation service is provided by local truck carriers, as well as by a number of truck carriers from Idaho and California.

Transcontinental U.S. Highway 40 at Carlin links Pine Valley with all eastern and western points. Nevada State Highway 20 traverses Pine Valley, connecting with U.S. Highway 40 at Carlin and with U.S. 50 near Eureka. Numerous other roads and truck trails provide access to most parts of the valley, at least during good weather.

Air transportation is available at Elko, with United Airlines providing one daily scheduled flight east and one west.

Trend in Size of Ranches

In 1960 the average size of ranch in Pine Valley was in excess of 7,000 acres. Acreage per ranch has shown a consistent upward trend since 1910.

According to agricultural census information for 1960, the average investment in land and buildings per ranch in the Pine Valley area was $108,000. Capital investment has varied widely, declining from $21,000 in 1920 to $11,500 in 1935 and then increasing gradually until 1945. Since 1945 the average value per ranch has increased more than 500 percent. In addition to investment in land and buildings, large amounts of capital in the form of livestock, machinery, equipment and supplies are required for ranch operation.

In 1959, 35 percent of the commercial ranches in the area sold agricultural products with a dollar value in excess of $25,000 per ranch. Ten years before, only 25 percent of commercial ranches had sales in excess of $25,000 per ranch.

Ranch Tenure

Most of the ranchers in Pine Valley are owner-operators. The number of ranchers owning all the land they operate has averaged more than 70 percent since 1900. However, the

trend for the recent 20-year period has been toward fewer full owners, more part owners, and a considerable decrease in tenant and manager-type operated ranches. In addition to land operated, ranchers hold permits to graze livestock on Federal lands.

Crop Production Rates and Practices

During the last 42 years, harvested crop production on Pine Valley ranches has consisted almost entirely of meadow hay, alfalfa, and other hay. Other crops, principally cereal grains, have constituted less than five percent of the annual acreage of crops harvested. Crop yields per acre are relatively low. Estimates of production of all hay for the 1919-60 period averaged one ton per acre, and varied from a low of .76 ton per acre in 1934 to a high of 1.26 tons per acre in 1959. Total tonnage produced varied more widely, from a low of 1,900 tons in 1931 to a high of 9,830 tons in 1941.

Recent trends in hay production are illustrated by comparing yields per acre and total production for the last two 10-year periods. The average yield per acre harvested increased 8 percent, from 1.01 to 1.09 tons per acre. Total production, however, decreased 25 percent, from an average of 8,125 tons during 1941-50 to 6,112 tons during 1951-60. The impact of the drought, beginning in 1953, on yield per harvested acre has either been negligible or has been more than offset by selection of the most productive acreage for harvesting and technological improvements. The impact of the drought on acreage harvested and total hay production, however, has been sharp.

Meadow or wild hay accounts for more than 90 percent of the acreage harvested. From 1919 to 1960, yield per acre of meadow hay averaged .86 ton per acre and varied from .54 tons in 1934 to 1.15 tons in 1941. The average yield per acre decreased 11 percent, from .90 tons per acre during 1941-50 to .80 ton per acre during 1951-60. Average acreage of meadow hay harvested decreased 32 percent and average total production decreased 38 percent.

The average yield per acre of alfalfa hay has shown a consistent upward trend during the past 20 years, averaging 1.62 tons per acre between 1941-50 and 2.20 tons per acre between 1951-60, an increase of 36 percent. During the same periods the average acreage of alfalfa hay harvested decreased 22 percent, while average total production increased 12 percent.

Production of other hay averaged .95 ton per acre for the 1919-60 period. Yield per acre of other hay increased 5 percent, from 1.35 tons per acre during 1941-50 to 1.42 tons per acre during 1951-60. Acreage harvested increased four percent and total production increased 17 percent.

A common measure of forage production from rangeland, irrigated pasture, dry pasture, and crop aftermath is the animal units of livestock grazed on these lands during the year. An animal unit month of grazing is defined as the quantities of feed or forage necessary to provide 425 pounds net total digestible nutrients and is approximately equivalent to the average feed required per month by a 1,000 pound cow and her calf.

The general practice of Pine Valley ranchers is to graze their livestock on the rangelands from about April 1 to October 15. The bulk of the livestock is then moved to the valley

bottom lands and grazed on irrigated and dry pastures and crop aftermath until the following April. Supplemental feeding of hay and concentrates usually begins in December and continues through March.

In 1960 all of the ranchers in Pine Valley had grazing permits. Tabulation of Bureau of Land Management use records indicates Pine Valley ranchers obtained an average of 6,940 animal unit months of grazing per ranch from Federal and intermingled private rangelands. Eighty-three percent of this use, or 5,737 AUM's, occurred during the six month period April 1 to September 30, an average of 956 animal units of livestock per ranch. Total average use per ranch is equivalent to 956 animal units for a period of 7.25 months. Grazing permits also allow grazing limited numbers of livestock on specified areas during the fall and winter months. Cattle accounted for 85.6 percent of the total use; sheep, 10.9 percent; and horses and burros, 3.4 percent. Eighty-three percent of total use was from Federal rangeland and 17 percent from intermingled private rangeland. (See table 9, Appendix I.)

Cattle Inventory and Production Rates

Estimates of the January 1 inventory of cattle on Pine Valley ranches for the period 1924-61 show cyclical movements which correspond generally with the cyclical pattern of streamflow. The number of all cattle and calves declined 55.4 percent, from 8,600 head in 1924 to 3,840 head in 1930. Numbers increased slowly between 1931 and 1935, then increased rapidly, reaching a peak of 9,960 in 1940. From 1941 to 1953 numbers fluctuated between 8,200 and 9,880 head. Since 1953 there has been a consistent decline. The estimate for January 1, 1961 was 6,720 head, a decrease of 22 percent since 1953.

Composition of cattle herds is also changing. During the late twenties, cows and heifers two years old and over accounted for about 45 percent of the total number of all cattle and calves. Currently, cows and heifers two years old and over account for about 60 percent of the total January 1 inventory of all cattle and calves.

The common measure of beef production for range herds is the turnoff of live beef per cow and per animal unit.

Estimates of turnoff per animal unit for Pine Valley ranches were developed for the 1924-60 period. The estimates represent the net amount of live beef marketed and shipped out of the area per animal unit of livestock in the herds on January 1. The estimates exclude inter-ranch sales, and have not been adjusted to reflect changes in inventory. They also exclude livestock butchered and consumed on the ranch.

During the forepart of the 37-year study period, the turnoff rate per animal unit declined rapidly, from 319 pounds in 1924 to a low of 188 pounds in 1932. The trend in the turnoff rate since 1932 has been upward, with a record of 371 pounds in 1960. The turnoff rate for the last six years has been influenced by annual reductions in livestock inventories, which increase the turnoff rate, and drought, which reduces the turnoff rate. A comparison of the average turnoff rate for the eight-year periods 1939-46 and 1947-54 shows an increase in turnoff rate of 16.2 percent, from 277 to 322 pounds per animal unit.

The weighted average price received by Nevada ranchers for cattle and calves marketed during the 10-year period 1951-60 was $20.67 per hundred weight. Applying this price to 322,

the average poundage of cattle and calves marketed, indicates average gross receipts of $66.56 per animal unit, or an average of $5.55 per animal unit month.

Water Supply-Production Relationships

An economic appraisal of the value of irrigation water requires the establishment of an estimate of crop yield response to variations in water supply. To measure this response, estimates of agricultural production and water supplies in Pine Valley for the period 1912-61 were developed.

The correlation between estimated total annual flows of Pine Creek at the gage, hay production, and cattle and calves marketed is shown in figure 2.

Hay production is affected by many additional factors, such as antecedent moisture conditions and water supplies, seasonal distribution of annual runoff, temperature, wind, disease, insects, rodents, fertilization, stand density, and management decisions as to when to harvest and whether to cut the hay or harvest it by grazing livestock.

Figure 2. - Annual Streamflow, Value of Hay Production, and Value of Cattle and Calves Marketed, 3-Year Moving Averages. Pine Valley, Nevada, 1912-1961.

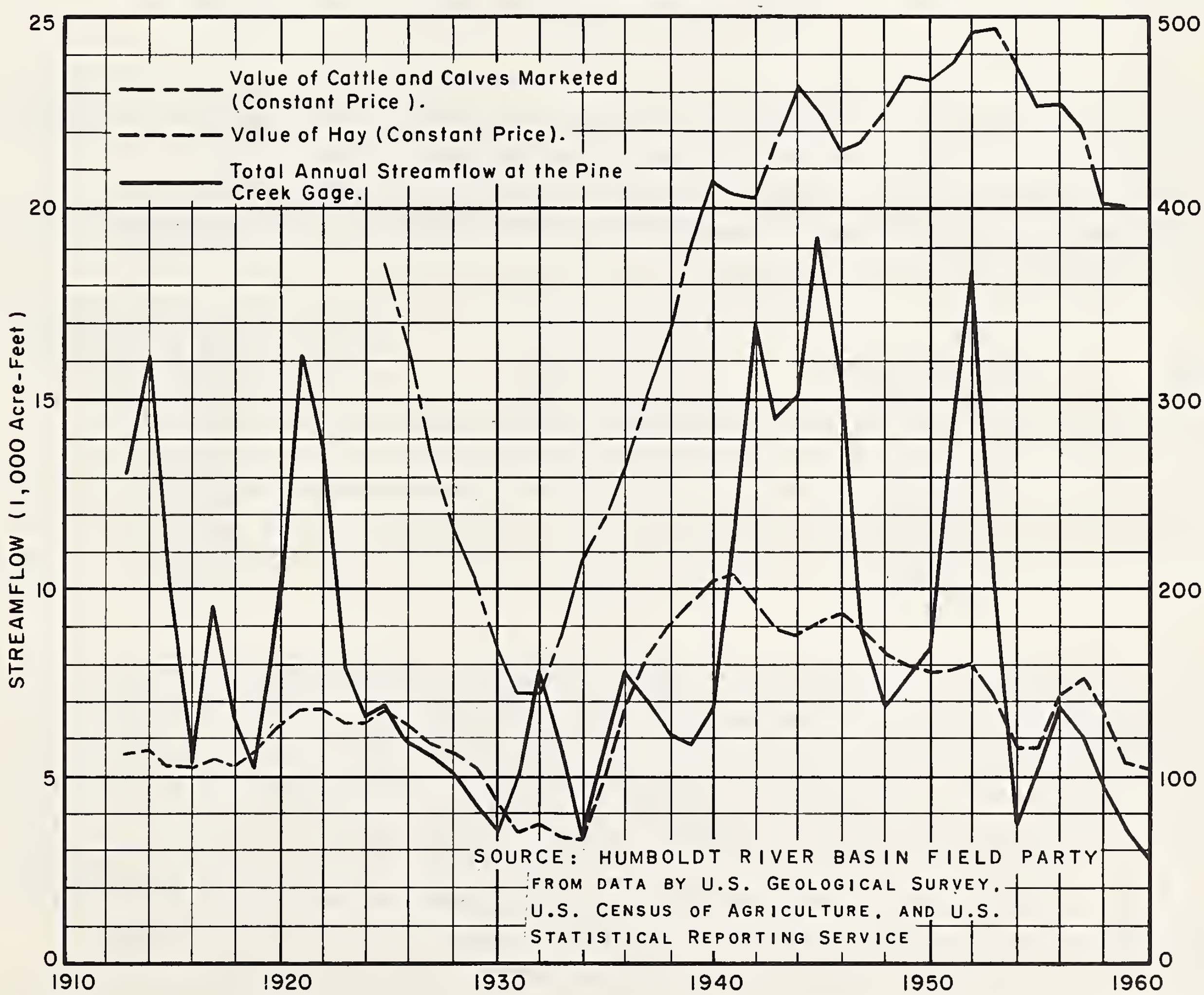
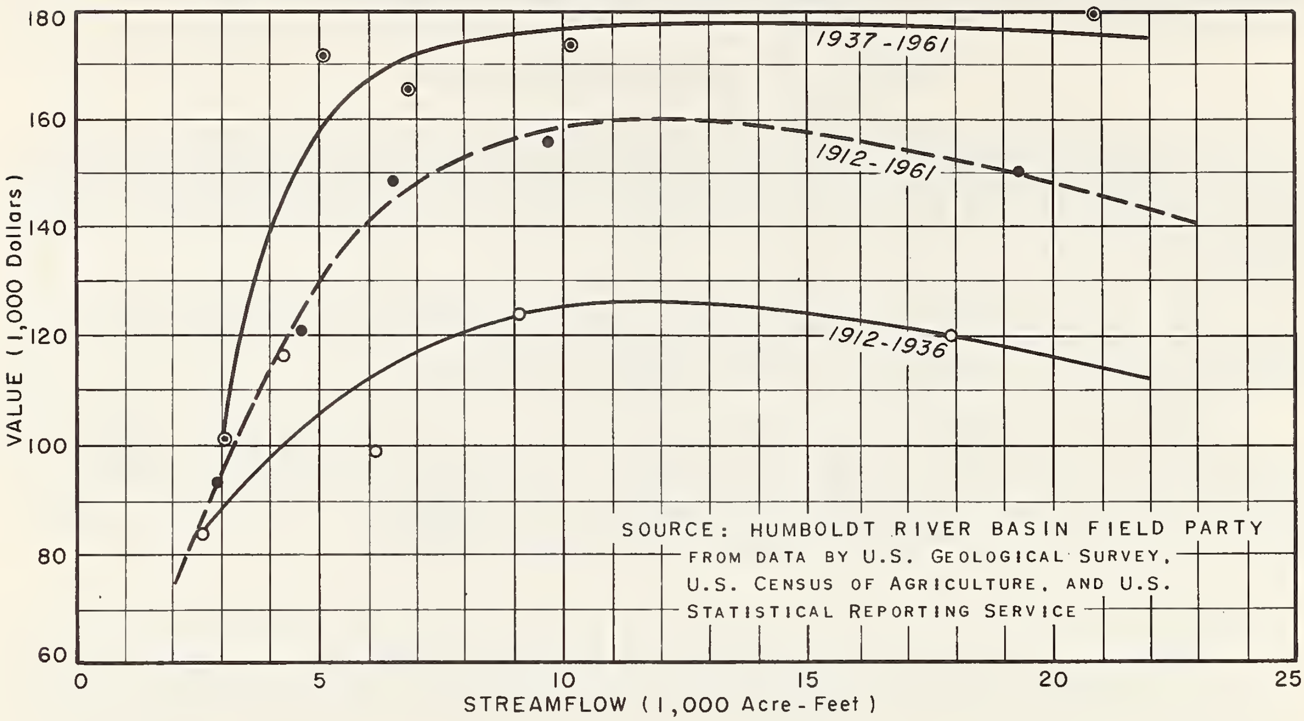


Figure 3. - Relationship Between Streamflow at Pine Creek Gage and Value of Hay Production at Constant Price. Pine Valley, Nevada.



To modify the effect on hay production of factors other than water supply, the 50 years included in the study period were arrayed in order of magnitude of runoff and divided into five 10-year groups. Means for both the water and hay groups were plotted, and a curve was visually fitted to the plotted points (see figure 3). The means of the groups and the ratio of the means between runoff and value of hay produced are shown in the following tabulation for the period 1912-61:

Group	Mean streamflow Acre-feet	Mean value of hay produced 1,000 dollars	Ratio value of hay produced per acre-foot of streamflow Dollars
1	2,816	93	33.02
2	4,654	122	26.21
3	6,493	148	22.79
4	9,686	155	16.00
5	19,340	150	7.76

The production function for water indicates that total hay production increases as runoff at the gage increases until runoff reaches about 9,700 acre-feet, after which hay production begins to decrease with additional runoff. Annual runoff at the gage does not represent the total quantity of streamflow available for irrigation in the valley, but is indicative of the variations in water supplies available to ranchers in the valley. It also indicates the relative efficiency of use of the variable streamflows. Average efficiency of water use decreases at a moderate rate as runoff increases until runoff reaches about 9,700 acre-feet, after which efficiency of use decreases rapidly. Excessive quantities of runoff at the gage are associated with decreases in the total value of hay produced in the sub-basin.

Efficiency of water use is associated with the status of land and irrigation development and the level of technology. To roughly indicate the impact of land and irrigation system development and technological advances which have occurred, the 50 years in the study period were divided into two periods, 1912-36 and 1937-61. Years within each of the periods were arrayed in order of magnitude of runoff and divided into five 5-year groups. The means of the groups were plotted for each period and a curve was visually fitted to the plotted points for each period (see figure 3). The means of the groups and the ratio of the means between runoff and value of hay produced for each period are shown in the following tabulation:

Group	Mean streamflow 1912-36	Mean streamflow 1937-61	Mean value of hay produced 1912-36	Mean value of hay produced 1937-61	Ratio value of hay produced per acre-foot of streamflow 1912-36	Ratio value of hay produced per acre-foot of streamflow 1937-61
	Acre-feet	Acre-feet	1,000 dollars	1,000 dollars	Dollars	Dollars
1	2,580	3,052	84	102	32.56	33.42
2	4,380	5,128	116	172	26.48	33.54
3	6,140	6,712	99	166	16.12	24.73
4	9,152	10,140	124	173	13.55	17.06
5	17,920	20,760	120	181	6.70	8.72
25 year means	8,034	9,158	109	159	13.57	17.36

Average annual water supplies during 1937-61 were 14 percent greater than during the 1912-36 period, and the total value of hay produced averaged 46 percent greater. These data indicate that about 18 percent of the increase in value of hay produced during the 1937-61 period was due to increased water supplies and 28 percent of the increase was due to increased efficiency of water use.

The efficiency of use of the variable water supply during the period 1912-36 declined further and quicker as runoff increased than during the 1937-61 period. Efficiency of use remained fairly high for the first three groups of 1937-61 period, indicating that ranchers in the valley are now situated so they can utilize the variable water supplies with about the same degree of efficiency six years out of 10, or until runoff at the gage exceeds about 7,000 acre-feet.

The investigations to date have been helpful in identifying the broad aspects of some of the problems involved. The more important of these are listed below. The problems listed are concerned with the physical and institutional factors, verification of which depends primarily upon technical disciplines other than economics. Establishment of their true character, however, is basic to an economic appraisal of the efficiency of the current use pattern of the land and water resources in the valley and the identification of possible modifications of the use pattern that might result in improvements in economic efficiency of use.

Establishment of the broad characteristics of the physical, institutional, and economic factors provide the basic framework of information essential to the identification of desirable

physical improvements, their direction and magnitude, and their economic effects. Some of these factors are:

1. Wide annual variations in the quantity of water available for irrigation result in wide variations in the annual volume of hay produced. Lack of water control facilities results in prolonged flooding of the hay meadows during extremely wet years and reduces both the quantity and quality of hay produced. During dry years production of hay is drastically reduced. Both of these situations impose difficult and costly adjustments in ranch management.
2. The amount of water available to satisfy water rights, in most years, is inadequate with respect to location, total quantity, and seasonal distribution.
3. Shallow ground water acquifers generally occur throughout the valley fill. The acquifers function as storage reservoirs for part of the high seasonal flows. The ground water, recharged in the early spring, is subsequently depleted by vegetation, and by outflow to surface streams in the valley and to the Humboldt River. It is estimated that less than 50 percent of the ground water use is by such economically valuable plants as alfalfa and the meadow pasture grasses. The balance is used by low value plants, principally greasewood and rabbitbrush.
4. Efforts to develop the deep ground water to supplement surface water supplies by drilling large capacity irrigation wells have been only moderately successful. The principal problems are dry holes, low water yield, excessive drawdown, and low quality water.
5. In many areas along the valley floor, restricted drainage, excessively high ground water, and accumulation of salts restrict the kind of forage plants which can be successfully produced. They also limit yields of crops which are tolerant to such conditions.
6. The occurrence of wet and dry cycles presents a serious problem to agriculture in the valley. The adjustment from the wet cycle to the dry cycle has been associated historically with widespread distress and large financial losses. The magnitude of the economic impact is indicated in figure 2. Between 1925 and 1934 hay production fell approximately 50 percent, and cattle and calves marketed declined about 55 percent. In terms of current prices (1951-60), the decline in cattle and calves marketed would have amounted to a maximum annual reduction in gross income of $191,000. The actual decline was from about $126,000 in 1924 to $29,000 in 1933, a 77 percent reduction in gross income, and resulted in widespread economic distress. The steep decline in the general economy and falling prices for livestock which occurred during the 30's were contributing factors. However, the decline in water supply was the controlling factor in the decline of hay production. The drought condition was also reflected by a decline in range forage production.

   While streamflow for individual years is very erratic, during the period 1912-61 there have been two wet cycles and two dry cycles. By computing the means of annual runoff for these periods, the magnitude of the decline in water supplies for extended periods of time is more readily apparent.

The estimated mean annual flow of Pine Creek, at the gage, for the 12-year wet period 1912-23 was 10,630 acre-feet; for the 17-year dry period 1924-40, 5,712 acre-feet; for the 12-year wet period 1941-52, 13,752 acre-feet; and for the nine-year dry period 1953-61, 4,488 acre-feet. A decline of 46 percent occurred in the mean annual flow between the periods 1912-23 and 1924-40, and 77 percent between the periods 1941-52 and 1953-60. The recorded flow of the Humboldt River at Palisade for the same periods shows a similar pattern, with a decline in mean annual streamflow between the two wet and dry cycles of 45 percent and 64 percent, respectively. Water resource developments which are instrumental in changing the pattern of land and water use to mitigate the severe economic impacts of the dry periods will be of great economic value to agriculture in Pine Valley.

Economic Framework for Evaluation

Factors listed below will affect the future needs for irrigation water and its economic value. Suggestions for improvements should be made with an awareness of these factors, some of which are:

1. The combined effect on natural requirements for agricultural products of population growth, improved dietary standards, and expected shifts in foreign exchange of agricultural products.
2. Shifts in economic advantage between regions of the country for production and marketing of major classes of agricultural products.
3. Growth of nonagricultural uses of the land and water resources, depletion of resources now used for agricultural production, retirement of inferior land from agricultural use, and the probable effects of these factors on the availability of land for agricultural production.
4. Advancement in agricultural production and marketing technology resulting from research, educational and technical assistance programs, and the resulting increases in production, marketing, and utilization of crops and livestock.
5. Alternative opportunities for resource development with expected levels of agricultural output and costs.

An essential first step is the establishment of the current situation with respect to the agricultural use of the land and water resources as a means of identifying some of the problems involved, which in turn indicate opportunities for adjustments and improvements.

WATER-RELATED PROBLEMS IN THE SUB-BASIN

Agricultural Water Management

Seasonal Distribution of Water

Irrigated lands, for the most part, receive but one irrigation from surface flow during the spring runoff. These conditions result in the production of low-yield forage plants which will tolerate wide extremes in soil moisture over extensive periods of time. Also, the acreage

of land harvested for hay will vary each year, depending upon the available water.

There are but few irrigation water storage developments at the present time, principally because of the lack of good sites. The developments now in use are of low capacity, serving but one owner.

Soils

The principal problems in soils are high water table, poor drainage, and salt and alkali concentrations. These problems usually occur on the cultivated lands and the flatter slopes in the valley bottoms. The soils are primarily of Alluvial Soils and Humic Gleys.

Control of Water

Irrigation and floodwaters are spread over the bottomlands by temporary structures made, in most cases, of earth and brush. There are some areas where the stream channel is very shallow and the water is spread naturally, without man made obstructions.

Water is partially controlled on the irrigated land by a system of gradient ditches. Most of these ditches are not equipped with turnouts, drop structures, or head gates for positive control of the water. There is, however, a limited use of corrugations to guide the water between ditches. A few fields which are irrigated with well water have been leveled to a uniform grade, and use the border system to control irrigation.

Irrigation Efficiency

Generally, lack of water control structures and poor seasonal distribution of water go hand in hand with low on-the-farm irrigation efficiency. The usual Humboldt Basin problem of water loss by deep percolation from over-irrigation and uneven application of water over undulating field surfaces make Pine Valley no exception. The irrigation efficiency here is about 20 percent.

Seepage Loss

Water loss from surface flow in ditches and creek channels is high when flowing over alluvial fans. It is reported that some lands cannot be irrigated except during periods of high runoff, even though there is adequate water at the point of diversion.

Drainage

Ground water is reported by the U.S. Geological Survey to occur generally throughout the valley fill. The water table is at zero to five feet below the land surface along Pine Creek down stream from the Slagowski Ranch, in the lower part of Garden Valley from the J.D. Ranch northward, and in scattered areas where seeps occur on the valley fill. At the other locations in the valley bottoms, depth to ground water averages 10 feet.

Shallow water tables limit the type of crops that can be grown on some ranches. These areas, however, are generally individual ranch problems.

Flood Damage

As with the other Humboldt sub-basins, there are two types of floods which have produced damage. They are: (1) the wet-mantle flood, resulting from the complete saturation of the soil mantle; and (2) the dry-mantle flood. The dry-mantle type occurs less frequently, and is usually localized at the stream sources on the higher watersheds.

Wet-Mantle Floods

The wet-mantle floods of 1881, 1890, 1910, 1917, 1921, 1943, 1952, and 1962 in Pine Valley produced sheet erosion damage resulting from prolonged rain on melting snow, or runoff over frozen range and meadow lands. These floods caused gullying and channel cutting along many stream courses. They also caused floodwater and sediment damage to irrigation structures and ditches, railroads, roads, and bridges, as well as to ranch buildings and haystacks. The wet-mantle floods of 1907 along the Humboldt and in the Sierra Nevada also produced damage in Pine Valley, although the extent of flood damage in the valley for that year has not been ascertained. There are no Pine Valley stream gage readings available for 1907 to indicate the volume of runoff.

The wet-mantle floods of 1910 and 1914, without doubt, wreaked the most havoc. Roger Bruffey and other long-time Pine Valley residents all state that the 1910 flood started the extensive gully system still active along lower Pine Creek and many of its tributaries higher on the watershed. This damage was extended and amplified by the floods of 1914 and 1921. (See photographs 5 and 6.) In 1910, approximately 30 miles of the Eureka and Palisade Railway in lower Pine Valley were almost completely destroyed. The estimated cost of rehabilitation was so great that the railroad management faced the auctioneer's hammer at a foreclosure sale late in 1910 rather than attempt the job. The line was sold at Eureka for a little over $77,000. The railroad remained closed until May 1912, when it resumed operation under a new management and title; the Eureka Nevada Railroad. To reduce potential flood damage, the line was relocated out of the Pine Creek bottom in many places.

Again in 1914, 1917 and 1921, the railroad suffered washouts of track and bridges. The 1914 high water took out three bridges on the line, including the 60 foot trestle over Pine Creek a mile south of Palisade. The train from Eureka was marooned by these washouts. Train service between Palisade and Eureka remained suspended for almost three weeks, from January 25 to February 11. In 1917, high water on Pine Creek resulted in damage to the railroad in the form of washouts of the grade and some small bridges over side streams. Train service was suspended this time for two weeks; from March 23 to April 7.

The February 13 to March 4, 1921 snowmelt floods washed out approximately 600 feet of railroad track and several bridges in the Pine Creek narrows, just above Palisade. Succeeding flood crests during this period caused further damage to the meadow lands and to the railroad.

Dry-Mantle Floods

The most disastrous dry-mantle floods were in the 1870's: July 24, 1874; July 24, 1876; and August 15, 1878. No definite information is now at hand concerning the damages in Pine

Photograph 5. - Eroded channel, Pine Creek, showing old Eureka and Palisade R.R. trestle. Photo taken May 5, 1961. 6-590-9 FIELD PARTY PHOTO

Photograph 6. - Same scene as photo 5, taken nine months later, after the 1962 wet-mantle flood. The channel has been widened and scoured, and the old trestle has been washed away. Photo taken February 13, 1962. 6-670-5 FIELD PARTY PHOTO

Valley from these storms, but property damage in Eureka a few miles to the south amounted to almost $200,000. In each instance, these floods resulted from a series of heavy convection-type rainstorms falling on watershed areas partially or completely denuded of their timber cover by heavy charcoal and fuelwood cutting.

A series of rainstorms on the poorly vegetated watershed range and timberlands in August 1961 resulted in localized damage from overland flows, which caused sheet and gully erosion and road and highway washins and washouts in lower Pine Valley.

Probably there have been other damaging dry-mantle floods in Pine Valley in the interval between 1878 and 1961, but the incidents listed here are the only ones of record.

Vegetation - Kind and Condition

Range and Watershed

Watershed conditions for most of this sub-basin are far from ideal; they are more fully discussed in a preceding section of the sub-basin report. Table 1 indicates the acreage by classes of present annual forage plant production, grouped by soils for each vegetal type and site. The rates in this table are indicative of the total annual forage production, and will be used as a basis for planning only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

Past heavy use of the range resource, and denudation of the pinyon pine stands, coupled with the decimation of the mahogany, bitterbrush, and other tall browse species by domestic livestock, and by big game in more recent times, has had its effect upon the watershed vegetal cover. This is particularly true of the medium elevation slopes in the Pinyon, Sulphur Springs and Cortez Ranges. The higher elevations of all these mountains are in somewhat better condition.

In most places in the sub-basin the pristine vegetal types have been thinned, completely removed, or replaced by inferior soil-binding species. This cover disturbance or removal has contributed to topsoil loss and the development of the present extensive gully system along lower Pine Creek and many of its tributaries. The loss of vegetal cover and topsoil, with the resultant gully formation, has enhanced the flood potential, as well as augmenting the amount of sediment damage in the lower portion of the sub-basin.

The deeply incised gully along lower Pine Creek has lowered the water table to such an extent that many formerly extensive areas of ryegrass and other grasses and sedges have been replaced by greasewood and rabbitbrush. As pointed out in an earlier section, however, some good has come from this lowering of the water table in the flat just above the junction of Pine Creek with the Humboldt, because it has made possible the establishment of a good stand of alfalfa.

Table 1. -- Acreage of present annual range forage plant production classes, grouped by soil associations for each vegetal type and site, Pine Valley Sub-Basin

Vegetal type and site	Acreage of forage plant production classes		
1. Rabbitbrush-greasewood-grass;	Production classes (pounds per acre) 1/		
saline bottomlands	850-1,500	200-900	20-300
Soil associations	(acres)	(acres)	(acres)
A5-H2	------	------	4,300
A6-H2	------	------	8,200
A6-H2-A5	------	------	18,700
H2-H9-A13	------	------	12,200
S9-Y1-A6	------	------	8,100
S9-Y1-A13	------	------	14,300
Subtotal			65,800
2. Big sagebrush-grass;	Production classes (pounds per acre) 1/		
upland benches and terraces	250-600	100-450	20-150
Soil associations	(acres)	(acres)	(acres)
B3-R10-S8	1,800	1,800	13,500
B4-R10-L4	------	6,900	10,000
B4-R10-S8	------	800	9,100
G2-G1	------	------	15,100
G2-S10-G3	------	------	39,900
G3-G2-L4	------	2,800	57,100
L1-B3	------	200	9,400
R10-C1-L1	11,200	17,200	4,200
S8-B4	------	------	24,400
S8-S9-B4	------	------	26,600
S9-B4-G1	1,800	------	78,600
S9-B4-R10	------	1,000	30,000
S10-G1-A5	------	600	13,000
S10-G1-S9	------	------	15,400
S10-S9	------	100	8,100
Subtotal	14,800	31,400	354,400
3. Shadscale-grass;	Production classes (pounds per acre) 1/		
droughty desert uplands	100-350	50-150	10-70
Soil associations	(acres)	(acres)	(acres)
Y1-S9	------	------	3,600
Subtotal			3,600

Continued

Table 1. -- Acreage of present annual range forage plant production classes, grouped by soil associations for each vegetal type and site, Pine Valley Sub-Basin -- Continued

Vegetal type and site		Acreage of forage plant production classes		
4. Browse-aspen-grass; intermediate mountain slopes		Production classes (pounds per acre) 1/		
Soil associations		300-650 (acres)	150-350 (acres)	50-200 (acres)
R11-C1-L1	(40-40-30)	2,200	19,200	42,100
R11-L1-C1-B4		600	11,500	10,300
	Subtotal	2,800	30,700	52,400
5. Pinyon-juniper-grass; shallow stony slopes		Production classes (pounds per acre) 1/		
Soil associations		100-250 (acres)	50-150 (acres)	10-75 (acres)
L1-R11	(60-40)	12,100	10,900	------
L1-R11	(70-30)	2,300	6,400	16,200
R11-C1-L1	(40-30-30)	2,600	38,200	4,300
	Subtotal 2/	17,000	55,500	20,500
	Total	34,600	117,600	496,700

1/ These figures indicate total annual forage production (dry weight), and will be used as a basis for planning needs only. Forage production figures will not be used for assigning range carrying capacities. These carrying capacities will depend upon such factors as slope, soil depth, soil character and stability, and the management objectives of the administrative agency.

The rates represent production variance from poor years to good years. At higher elevations within the site, with greater precipitation the rates would be higher, and conversely for lower elevations.

2/ Does not include 4,000 acres of waste, barren, or inaccessible.

Source: Humboldt River Basin Field Party

Phreatophytes

The phreatophytes of low economic value consist almost entirely of rubber rabbitbrush and greasewood, which usually are found in mixed or practically pure stands. There is very little willow present; what little is found is located along Willow Creek and a few other small streams in the southern Cortez and Roberts Mountains.

At the north extremity of the sub-basin, and extending southward to the vicinity of the Simplot iron mine road, rabbitbrush is the principal phreatophyte species. It also occurs in almost pure stands along the bottomlands of Pine, Smith, and Papoose Creek, with a thin understory of Great Basin wildrye, squirreltail bottlebrush (Sitanion hystrix), and a perennial mustard (Thelepodium).

Along the middle reaches of Pine Creek, from the Simplot road to a short distance south of the Slagowski Ranch, greasewood is dominant, with an admixture of rabbitbrush on the outer fringes of the type. Whatever scattered grass-forb understory occurs is of similar composition as just described for the rabbitbrush types farther north.

South of the Slagowski ranch, on Pine Creek and its tributaries, rabbitbrush is again dominant, with a scattering of greasewood. Because of increased soil salinity along the Pine Creek bottom, the ryegrass understory gives way to a saltgrass stand of varying density. (See photograph 7.)

On Henderson Creek through Garden Valley, from the Knight Ranch near its junction with Pine Creek to the Alpha Ranch, and on lower Pete Hanson Creek, rubber rabbitbrush is the dominant phreatophyte, with fringe areas of almost pure greasewood. (See photograph 8.) The understory here is principally saltgrass, with a scattering of ryegrass higher in the valley. On upper Henderson Creek, from the Alpha ranch to the southern rim of the sub-basin, rubber rabbitbrush is dominant, with an understory composition very similar to that found on Pine Creek at the north extremity of the sub-basin.

The few rabbitbrush types found on lower Denay and Horse Creeks, and on the wide alluvial areas on the east side of Pine Valley north of the Trading Post, are comparable in composition and density. The dominant rabbitbrush is fringed with greasewood, with a usually thin understory of Great Basin wildrye, some bottlebrush squirreltail, and a few perennial weeds. (See table 2; also Phreatophyte Map, Appendix I.)

A rather intensive phreatophyte inventory was made in this sub-basin, using the point-observation plot (square foot) method of sampling type densities and composition. In general the phreatophytes were found to be rather low growing; usually a little over or a little under three feet in height. Densities were also comparatively low, as may be seen from table 2.

Fire Protection

From the earlier discussion of past fires, it is evident that fire has been of considerable significance as a causative agent of watershed damage and deterioration, particularly in the Sulphur Springs and Cortez Ranges on the east and west sides of Pine Valley. With deterioration or destruction of the original plant cover, whether caused by fire or other watershed abuse, the resultant vegetation increases the fire hazard by providing flashy fuels. To some extent, this problem has been ameliorated by the Bureau of Land Management's reseeding program on extensive acreages of the 1957 N.T. Springs Fire on the southeast side of Pine Valley, and the Willow Creek Fire on its southwest side.

As time goes on, risks of fires caused by the steadily increasing recreation and hunter use of the watershed wild lands will continue to mount. The importance of these lands as water-yielding areas for this arid valley make fire protection a factor of increasing significance. Prevention or prompt suppression of potentially disastrous range or timber fires is now and will continue to be an important facet of proper resource and watershed management.

The Bureau of Land Management fire program is briefly explained on page 38. The State of Nevada at present has no organized fire protection district in the sub-basin.

Photograph 7. - Greasewood and rabbitbrush phreatophyte type with scattered saltgrass understory, Pine Valley. Looking south up Denay Valley and Horse Creek; Cortez Mountains on right, Simpson Park Mountains in left background.

6-606-8 FIELD PARTY PHOTO

Photograph 8. - Greasewood fringe area in vicinity of Knight Ranch. Roberts Mountains in background. 6-606-10 FIELD PARTY PHOTO

Table 2. -- Phreatophyte acreage and annual ground water use, Pine Valley Sub-Basin

Species	Height class	Density	Acreage cropland	Acreage range types	Annual ground water use (feet)	Annual ground water use (acre-feet)
Black greasewood	3'-	.02-.07	-----	1,700	.2	340
	3'+			16,000	.3	4,800
Rubber rabbitbrush	3'+	.03-.07	-----	6,700	.3	2,010
Saltgrass	---	.04-.05	-----	1,620	.5	810
Creeping wildrye	---	.05	-----	250	.6	150
Great Basin wildrye	---	.04-.07	-----	3,900	.6	2,340
Sub Total				30,170		10,450
Irrigated meadow hay and pasture 1/	---	-------	4,800	------	.4	1,920
Wet meadow	---	-------	400	------	.8	320
Alfalfa	---	-------	400	------	.4	160
Sub Total			5,600			2,400
Total			5,600	30,170		12,850

1/ Mixture of Great Basin wildrye, creeping wildrye, other grasses, and sedges.

Source: Humboldt River Basin Field Party

RECREATION AND WILDLIFE

Recreation Developments

At present, there are no camp and picnic areas or any other recreation development in this sub-basin. The Elko District of the Bureau of Land Management, in its 1959 recreation inventory report, proposes development of several campgrounds and historical sites in Pine Valley, as shown in table 3.

Several other potential recreation, camp, and picnic sites were observed by the Field Party. They are submitted herewith as suggestions only, for whatever value they may possess. One such site is in the aspen stands along Big Pole Canyon, above the old Hall Ranch. Two others were noted on Trout Creek, along the Trout Creek-Dixie Flat Road across the Pinyon Range. The first of these is located in the aspen grove on the South Fork of Trout Creek, about a mile east of its junction with the north fork of that stream. The other site is in the high, open basin at the head of the South Fork of Trout Creek, just west of the pass across the Pinyon Range. These appeared to be the best of the possible sites encountered, because of their beauty and accessibility, and also from the standpoint of camp water development, low fire hazard, and ease of site development.

Wild Life

Deer Hunting

Since 1890 the deer population of the valley has built up from almost a vanishing point. Consequently, deer use of the forage resource of Pine Valley has become a factor of increasing significance. Management was introduced with the establishment of the old County Warden system and the sale of hunting licenses about 1908. Both measures have aided herd regeneration. Since 1948, when the present Nevada State Fish and Game commission was set up and scientific methods of big game management instituted, deer numbers have continued to increase. The Pine Valley deer herds use the higher elevations of the Pinyon, Roberts, Simpson Park, and Cortez Mountains as summer range, and winter on the lower slopes and the valleys.

A major portion of the sub-basin, with the exception of the northern end of the Pinyon range, is in Game Management Area 14. The north Pinyon portion is in Area 10. Area 14 is administered by the Wheeler District of the Nevada State Fish and Game Commission at Ely, with the exception of deer herd counts, hunter success censuses, etc., which are handled by the Owyhee District at Elko, it being somewhat closer to most of Pine Valley. The Elko office administers Area 10.

A six week either-sex deer season is set up for Nevada residents in both these management areas, running from about October 7 to November 19 each year.

An additional number of either-sex tags is issued to out-of-state hunters in both management districts, as well as a number of special antlerless deer tags. For example in Area 14 for 1961, 325 either-sex tags were issued to out-of-state hunters, and 470 special anterless deer tags to either resident or nonresident hunters, with the resident hunters having the preference.

Table 3. -- Recreation inventory report, 1959, national land reserve lands, Pine Valley Sub-Basin

Site name and type of development	Acres	Site devel. cost	Access roads				Trails		Water devel. cost	Total devel. cost	Area affected acres	
			Miles	Construct. cost	Right of way acquisition cost	Yearly maint. cost	Miles	Devel. cost			BLM	other
Buckhorn ghost town historical area camp site	200	$400	5	$3,000	------	$125	--	------	----	$3,400	320	---
Blue Mountain camp site (Cortez Mts.)	200	$500	3	$1,200	------	$ 45	30	$1,500	$300	$3,500	320	---
Cottonwood camp site (Cottonwood Creek, Cortez Mts.)	200	$500	10	$2,500	------	$150	15	$ 750	$400	$4,150	320	---
Cortez Mts. scenic drive (Little Pole Canyon-Big Pole Canyon)	---	----	20	$5,000	$2,000	$300	--	------	----	$7,000	120	120
Mineral Hill ghost town historical area camp site	300	$500	5	$2,000	------	$ 75	--	------	$400	$2,900	320	---

Source: Bureau of Land Management, Elko District

In area 10, 1,600 either-sex nonresident tags were issued for 1961, and 1,780 anterless deer tags to either resident or nonresident hunters.

The 1960 total deer kill for Area 14 was 116 bucks and 39 anterless deer, based on the voluntary return of deer tags to the Commission. These figures are on the conservative side, probably representing from 60 to 70 percent of the actual kill. According to studies made by the Commission, the number of deer taken is fairly close to the kill numbers planned. The same is true for Area 10. In 1960 a total of 1,589 bucks and 1,398 does were taken. Only a small portion of these were killed in Pine Valley; the balance of the kill came from Dixie Flat. More hunters are needed in Pine Valley, to bring the deer kill more in balance with the herd increase.

Fishing

Fishing, now almost passed from the scene, was once quite important, as the following news item from the May 31, 1913 issue of the Eureka Sentinel indicates.

> "Two families (from Eureka) went to the Roberts Creek Mountains last Sunday for an outing. The party caught 39 rainbows (trout) of good size."

Dwindling water supplies, increasing alkalinity, and the deterioration of the watershed and its capacity for water interception and storage have reduced the flow of many of the smaller perennial streams in the sub-basin to intermittent periods of flash floods or high water, followed by periods of little or no flow at all.

The Nevada State Fish and Game Commission still plants fish in a few of the streams draining the Roberts and Simpson Park Mountains. In 1955 and 1956, 14 pounds of rainbow trout six inches and over were planted annually in Henderson Creek at the Alpha Ranch, and the same amount in upper Denay Creek. For 1957, an additional 364 pounds of six inch or over eastern brook trout were also planted in upper Denay Creek.

Fish plantings since 1957 are based on a revised fish allocation system of 101 pounds of six to eight inch eastern brook or rainbow trout, preferably rainbows. Large-mouth bass were planted in the J.D. Ranch reservoir in 1958 and 1959. Plans proposed by the Nevada State Fish and Game Commission and the Elko District of the Bureau of Land Management envision the eventual stocking of lower Pine Creek, from the Hay Ranch to its confluence with the Humboldt, with some species of warm-water fish. This presupposes that the year-round water level in the Pine Creek channel can be maintained at a higher level than is presently possible.

In the past, trout have been caught in many of the beaver ponds at the headwaters of Trout Creek, according to the Nevada State Fish and Game Commission, but recent water levels (1960-1961) have become almost too low to support fish life.

PROGRAMS OTHER THAN PROJECT-TYPE DEVELOPMENTS AVAILABLE FOR THE IMPROVEMENT OF WATER AND RELATED LAND RESOURCES

Lands in the sub-basin can be treated or can receive aid for treatment under existing U.S. Department of Agriculture and other Federal and State programs. The Bureau of Land Management is responsible for range, recreation and watershed development on the national land reserve lands which it administers. The owners of private land can receive aid for water and related land resource development by means of various programs under the U.S. Department of Agriculture.

Technical Assistance and Cost-Sharing

Under the provisions of Public Law 46 the Soil Conservation Service furnishes technical assistance through Soil Conservation Districts. Under this program, assistance in developing coordinated conservation plans and in applying conservation measures may be furnished for farms and ranches. These plans provide for land use adjustments, erosion control, water conservation, irrigation, drainage, and flood prevention. Solution to the sub-basin problems on private land may be arrived at in part by the use of such technical assistance, and through cost-sharing under the Agricultural Conservation Program administered by the U.S. Agricultural Stabilization and Conservation Service.

Agricultural Water Management

Opportunities for improving water management conditions on individual ranches are common throughout the sub-basin. Treatments for various types of problems are listed below.

Problems	Suggested Treatment
1. Wet areas caused by springs and seeps,or ponding caused by surface drainage	a. Install surface or subsurface drainage systems. b. Land smoothing or land leveling to improve the field surface. c. Reorganize water distribution and irrigation system for better irrigation water control.
2. Limited water supply	a. Increase water supply by drainage of seeps, springs, and high water table. b. Control of phreatophytic plants. c. Construct overnight storage reservoirs to better utilize small flows for irrigation. d. Investigate possibility of irrigation water wells. e. Remove "tight dams" and install control structures in channels and ditches.

Problems	Suggested Treatment
	f. Line or seal ditches through reaches of excessive seepage. g. Stop applying water after soil reaches saturation
3. Saline soils.	a. Install drains to lower water table. b. Use only good quality water for irrigation to reduce salt concentration in the soil. c. Use proper soil and water management practices.
4. High water table.	a. Install suitable drainage. b. Improve creek channels for drainage outlets and the reduction of frequent flooding of bottomland. c. Check possibility for pump drainage. This may increase water supply for irrigation. d. Land smoothing to remove low ponding areas.
5. Low efficiency use of water.	a. Level land for even water application. b. Reorganize water distribution and irrigation systems. c. Line ditches through highly permeable soils. d. Stop applying water when soil becomes saturated. e. Plant high-yielding crops suitable for conditions, to reduce irrigated acreage now needed for hay production. f. Increase water management efficiency.
6. Inadequate water distribution systems.	a. Remove "tight dams" and install controlled diversions. b. Reorganize water distribution systems. c. Use lined ditches or pipe lines through highly permeable soils. d. Construct necessary control structures in ditches.

Vegetal Improvement

Stream bank cutting and channel erosion as well as watershed erosion on privately owned land indicate the need for action to reverse the trend toward meadow desiccation and land deterioration. Each of the following solutions would contribute in some measure to improvement of plant species and cover, which in turn will help reduce this erosion.

Problems	Suggested Treatment
Irrigated lands	
1. Meadow desiccation, floodwater and sediment damage.	a. Install structures that will stop channel cutting but will allow proper drainage. b. Slope stream banks to reduce velocity of flow and permit grass planting on these slopes. Protect these treated stream banks from cattle trampling by fencing. c. Install floodwater diversion ditches and dikes, to control sedimentation and floodwater damage.
2. Low yields.	a. Establish higher yielding forage crops suitable to the soil and water conditions, for hay and pasture. b. Use irrigation methods that will permit more efficient use of water and create an environment for higher producing forage plants. c. Develop a fertilization program.
Nonirrigated lands	
1. Range condition static or on decline.	a. Practice rotation-deferred grazing. b. Use bottomland pasture to supplement available range. c. Control low economic value plant growth to increase forage production. d. Develop a program of reseeding the rangelands. e. Establish proper use practices.
2. Lack of proper management.	a. Fence to enable better grazing control and proper range use. b. Improve salting and water distribution for better grazing control.

Watershed Protection and Erosion Control

The sparse cover on most of the range land is conducive to sheet erosion. Vegetal treatment (spraying, reseeding, etc.) in the source areas would probably be the best answer to the problem. Generally, the topography of the upper watershed lands is too steep for practical and effective sediment and erosion control structures.

Channel and gully erosion control is needed in the valley bottoms, to protect the existing meadows and restore desiccated meadowlands. Permanent type control structures placed at selected sites are considered to be the most economical treatment. In conjunction with structural measures, bank sloping, seeding, and fencing will help heal the channel bank-cutting and stream meandering.

Possibilities for Water Salvage

The Field Party estimated that 12,850 acre-feet of ground water were used annually by phreatophytic plants. This estimate includes the water used by Great Basin and creeping wildrye, which are the primary plant species used for hay and pasture.

Plants of low economic value, such as black greasewood, rubber rabbitbrush, and saltgrass, use an estimated 8,000 acre-feet of water annually. This type of plant growth is difficult to eradicate; however, it is thought that more effort should be made to control or replace these water-competitive plants with forage of higher economic value.

With ground water quality being questionable, pumping for irrigation may not be the answer as a method of lowering the water table to reduce phreatophytic growth. Deep subsurface drains or shallow pumping from pits are procedures which could be used to help control these undesirable plants.

Other Federal and State Programs

Bureau of Land Management Programs on the National Land Reserve

The Bureau of Land Management is responsible for the administration and management of about four-fifths of the Pine Valley Sub-Basin. Highlights of the Bureau of Land Management's range management program include the protection, proper use, and improvement of the national land reserve.

Grazing adjudication, a phase of the range management work, includes (1) a review and study of the base property and development of records for each grazing user; (2) an up-to-date range forage inventory; and (3) adjustment of the stocking rate to current available forage. The program also envisions defined seasonal areas of use, range administration, and developing range improvements necessary to obtain proper distribution of livestock and more uniform and proper use of forage.

The soil and moisture program is integrated with the grazing program and consists of stabilization and rehabilitation projects necessary to conserve soil, water, and closely related resources. The work also includes improvement of vegetation through natural revegetation, control of undesirable forage plants, and the reseeding of more desirable plants.

The weed control program on the national land reserve is designed to arrest the invasion of new weed species which are poisonous or mechanically injurious to domestic livestock or threaten the agricultural economy of the area.

The national land reserve in Pine Valley, along with intermingled private land, provides an important winter range for deer. Small resident bands are found in the Pinyon Range west of Bullion, and in the vicinity of Union Summit and east of Mineral Hill, in the Sulphur Springs Range. The largest number of big game animals is present during the winter months when herds migrate into the area from the Ruby and Tuscarora Mountains. Summer use by cattle and sheep, followed by winter deer use, has resulted in a weakened stand of bitterbrush. This shrub, so important to wintering deer, exhibits a hedged appearance, along with poor vigor. The Bureau of Land Management has reserved sufficient forage for a reasonable number of big game animals,but a definite deer harvest problem exists, because of limited access to the area and the lateness of the season when the deer move into it.

Other game species present on the national land reserve in Pine Valley include the chukar partridge and sage grouse. The numbers of both these upland bird species are now increasing in Pine Valley, but neither species is present in sufficient numbers to afford regular hunting seasons.

Land classification, fire protection, and recreation are important phases of the broad Bureau of Land Management program. The long range land program includes encouraging land exchanges, in order to establish a more desirable land pattern. Fire occurrence maps, classification of fuel types, a better detection system, and the inauguration of a fire danger rating system by the Bureau of Land Management has ameliorated the fire situation to some extent. The Bureau's recreation program is briefly outlined in table 3.

WATERSHEDS WITH OPPORTUNITIES FOR PROJECT-TYPE DEVELOPMENT

The need for supplementing the present soil and water conservation programs and for developing flood protection in the Pine Valley Sub-Basin is evident. Significant problems exist which affect and require action for their solution by groups of landowners, the community, and the public through cooperation of local, state and federal governments.

Public Law 566, the Watershed Protection and Flood Prevention Act, provides for a project-type approach to soil and water resource development, use, and conservation. It authorizes the Secretary of Agriculture to assist local organizations in carrying out such programs, and provides also for needed treatment and protection on federally owned lands within project areas.

There are opportunities for project development in Pine Valley. The sub-basin is of such size that it would need to be divided into four interdependent watersheds of less than 250,000 acres. Each of the four watersheds must be planned and the projects installed concurrently. Because of the close tie in the use of crop and range lands, the total benefits from all watersheds must be compared to the total costs of all the structural and land treatment measures in these watersheds.

The objective of protection, stabilization and improvement of the soil and water resources is to be accomplished by:

1. Stabilization of stream channels to prevent further meadow destruction and dessication by flood flows and to help maintain a beneficial water table.
2. Improvements in the supply and use of water for agricultural purposes.
3. Reduction of erosion and soil deterioration on range land through improvement of vegetal cover.
4. Development of recreational opportunities, including management and utilization of the wildlife resources of the watershed.

These projects would help to maintain a healthy economy for ranch enterprises in the watersheds, and result in a general improvement of the economy of the surrounding area and the entire river basin.

Range Improvement

In its present condition, 77 percent of the sub-basin's range is in the low forage production classification, and only five percent in the fairly high production class. In order to prevent further deterioration of the soil resource it will be necessary to improve the protective cover by acceleration of the conservation program presently being carried out by the Bureau of Land Management and the private land owners.

The program contemplated would require coordinated planning of operations on the intermingled private and public lands, so that the total area may be fenced into allotments and management units for deferred-rotation grazing. Common use by sheep and cattle would need to be eliminated on all allotments, to afford more positive control of livestock use. Sufficient provision must be made in carrying capacity determinations on each allotment to provide for

deer use, particularly on the deer winter range areas in the Pinyon Range west of Bullion, and in the Sulfur Springs Range near Union Summit and Mineral Hill. In each allotment the necessary water to facilitate proper livestock distribution and uniform utilization of the range would need to be developed, suitable reseeding sites would need to be plowed and seeded, sagebrush and other low value or undesirable browse plants sprayed on selected sites, and an intensified range management plan developed. Insofar as possible, winter grazing use of the Federal range should be eliminated, except on the lower ranges contiguous to bottomland livestock feeding areas which are suitable for fall and early winter use.

About 220 miles of allotment and management fencing, 15 stockwater developments (springs and wells), 17,500 acres of reseeding, and 75,000 acres of spraying would be required to put this plan into operation. The present weed control program on the national land reserve should be accelerated, so that the extensive halogeton areas in the sub-basin may be reduced or eliminated.

These improvements will provide the necessary watershed protection and will increase the acreage of range in the fairly high forage production class to about 50 percent of the total area and reduce the acreage of range with low forage production to about 12 percent.

Channel Stabilization

The lower end (north end) of Pine Creek has active head-cutting working its way upstream through meadow hayland. At the present time the channel should be protected in at least two places.

The most active cutting is in the north half of Section 21, T. 31 N., R. 52 E. The channel here is about 20 feet deep and 50 to 200 feet wide (see photograph 7). If this erosion is allowed to move at its present rate, 580 acres of meadow hayland will eventually be desiccated, with 40 acres being lost to the encroaching channel. A concrete drop spillway structure at the lower end of this meadow would require about 450 cubic yards of concrete and 11,000 cubic yards of compacted earth fill in a dike (see photograph 8).

In the south half of Section 5, T. 30 N., R. 52 E., the cutting is not too active at the present time. A straight channel has been dug in the lower end of this meadow which is about seven feet deep and 25 feet wide at the top. One wooden drop structure at present helps to protect this channel from further head-cutting. The structure will not carry all the normal spring runoff; the water spreads out and goes around each end. If this wooden structure is not replaced in a relatively short period of time, there is a danger that about 280 acres of meadow would be desiccated, with 23 acres being lost to the channel.

A permanent concrete box inlet drop spillway would be needed to replace the wood structure, and should be relocated downstream to the lower end of the meadow. This drop would require about 350 cubic yards of concrete and 3,100 cubic yards of compacted earth fill in a dike.

In addition to protecting the meadowlands, these two structures would reduce sediment damage downstream in Pine Creek and along the Humboldt River. It would also help to maintain a better balance between the interdependent use of the Federal range and the production of an adequate winter hay supply.

Photograph 9. - Headcutting above possible structure site on lower Pine Creek, lower Tomera Ranch, looking west into west headcutting from a point about 400 feet above structure site. Photo taken April 9, 1962. 6-673-3 FIELD PARTY PHOTO

Photograph 10. - Site of possible drop structure on lower Tomera Ranch. Looking north from wooden piling down Pine Creek Channel. Photo taken April 9, 1962.
6-673-1 FIELD PARTY PHOTO

Cropland Improvement

In order to secure maximum conservation benefits from channel stabilization structures and to obtain a better balanced livestock program, it will be necessary to double hay production on the cropland area. Methods of increasing production would include the following:

1. Plant improved meadow grasses and legumes suitable for hay.
2. Remove livestock from hay meadows during periods when the ground is wet. Feed lots should be located on less productive sites.
3. Develop a fertilization program on meadow hay and pasture lands.
4. Develop water for summer irrigation.
5. Drain wet areas so that a beneficial water table can be maintained.
6. Improve the water distribution and irrigation systems so as to provide for a more uniform and better controlled water application.

The lack of good sites for irrigation reservoirs and the generally poor quality of water obtained from deep wells make water development a problem. Shallow ground water in most areas of the sub-basin is of fair quality for irrigation use and is probably the best source for small fields. Pumping from pits would be the best method of development. Drainage of wet areas would be another method of obtaining shallow ground water. Small diameter deep test wells should be drilled throughout the area to locate possible sources of good quality water. The fields being irrigated from this shallow ground water source should be leveled and planted to a high-yielding crop, such as alfalfa.

Eradication and control of phreatophytes in the bottomlands could supply additional water to the area. An estimated 10,500 acre-feet of water are used annually by phreatophytic plants of low economic value. About 3,000 to 5,000 acre-feet of this water could be recovered for beneficial use.

Three-fifths of the increased hay supply can be obtained from improved meadow planting and good management practices, and two-fifths from 750 acres of alfalfa irrigated with shallow ground water.

Accomplishing the Improvements

A preliminary evaluation of the measures involved in accomplishing the improvements outlined indicates that current deterioration of resources could be essentially stopped, watershed and wildlife conditions tremendously improved, and the combined range and irrigated forage production increased about 250 percent. This preliminary evaluation also indicates that the improvements could be accomplished through watershed project operations as authorized under the Watershed Protection Act (Public Law 566 as amended).

The development of such project operations would need be initiated by a local sponsoring organization representing the landowners and operators. The sponsoring organization could initiate such action by submitting an application for watershed project planning assistance to the Director of the State Department of Conservation and Natural Resources.

Under the provisions of the Watershed Protection Act, and the operations procedures as

developed by the U.S. Department of Agriculture, a local sponsoring organization would provide needed land rights for structural improvements, and assume the responsibility for contracting the structural work and for its subsequent operation and maintenance.

The landowners would have responsibility for the installation of land treatment measures on the privately owned lands. Cost sharing and credit assistance could be made available by the U.S. Department of Agriculture for such work.

The Bureau of Land Management would assume responsibility for the installation of land treatment measures on the Federal lands which would be accomplished with the usual participation in costs by the range users.

Funds appropriated under the Watershed Protection Act can be made available to defray the cost of construction of the structural improvements for flood and sediment damage prevention. They can also be made available for installing land treatment measures on the Federal lands which are primarily for the improvement of vegetal cover (range seeding and brush spraying).

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APPENDIX I

Pertinent elaborative material of value to the general reader, for his reference and guidance in the use of the sub-basin report.

Table of Contents

SOILS DESCRIPTION

The generalized soil survey of the Pine Valley Sub-Basin shows the location and distribution of different kinds of soils by associations of Great Soil Groups. Each Great Soil Group includes a number of soils with similar internal characteristics that reflect the environmental conditions responsible for their development. Great Soil Groups mapped in the survey include:

Alluvial Soils (Symbol: A)

These are the soils that consist of essentially recent stream-laid deposits; alluvial fans, floodplains, terraces and basins. They have essentially no profile development, but a little organic matter may have accumulated. They are usually deep, stratified, variable with regard to drainage class, and occur under many different climates.

Brown Soils (Symbol: B)

These are the soils which have dark brownish A horizons about six inches thick, textural B horizons 10 to 15 inches thick, and calcareous parent material of variable thickness. Some of these soils have cemented calcium carbonate layers in the C horizon and some may have the C horizon resting on bedrock. They are usually moderately deep to deep, well drained, and occur under a cool semi-arid climate with an average precipitation of 10 to 14 inches. Most of the Brown Soils in the Pine Valley Sub-Basin occur at elevations above 5,000 feet, in the uplands.

Calcisols (Symbol: G)

These soils occur on highly calcareous parent material in the arid and semi-arid regions. They have developed where leaching is limited, but have formed under good to excessive drainage conditions. They include soils in which the calcium carbonate has accumulated to form a prominant Cca on Dca horizon near the lower depth of wetting. They have a light grey-brown A or A1 horizon, about 10 to 15 inches thick, which becomes lighter colored with depth. They are moderately deep, well drained, and occur with an average annual precipitation of about eight to 10 inches at elevations below 6,000 feet.

Chestnut Soils (Symbol: C)

These soils have dark grayish brown to very dark grayish brown A horizons about six to eight inches thick, textural B horizons 10 to 15 inches thick, and parent material that may or may not be calcareous. These soils usually have darker A horizons more organic matter, and have been more strongly leached than have the Brown Soils. The parent material may or may not rest on bedrock. They are usually moderately deep to deep, well drained, and occur in a cool semi-arid climate with an average precipitation of about 14 to 18 inches. Most of the Chestnut Soils in the Pine Valley Sub-Basin occur at elevations above 5,500 feet, in the uplands.

Humic Gley Soils (Symbol: H)

These are the dark brown or black meadow soils that grade into lighter colored and/or

rust-mottled grayish soil at depths of one to two feet. They are imperfect to poorly drained, usually with seasonal fluctuating high water table, and occur along stream floodplains where they are subject to overflow. They occur in a cool semi-arid climate, and are found in the Pine Valley Sub-Basin at elevations mostly below 6,000 feet.

Lithosols (Symbol: L)

These soils have an incomplete profile, or no clearly expressed morphology. They are shallow (less than 10" - 15"), and consist of freshly and imperfectly weathered masses of hard rock or hard rock fragments, and are largely confined to steeply sloping lands. In the higher rainfall areas of the sub-basin, some of these soils may have dark A horizons. They are usually excessively drained.

Regosols (Symbol: R)

These are soils which consist of deep unconsolidated deposits, in which few or no clearly expressed soil characteristics have developed. They are largely confined to recent sand dunes and colluvial accumulations on steep mountain slopes. Under eight to 10 inch rainfall the Regosols may have only a weakly developed A horizon, while in higher rainfall areas they may have well developed dark A horizons six to 14 inches or more thick. In mountainous areas these soils may be underlain by bedrock 15 to 20 inches below the soil surface.

Sierozems (Symbol: S)

These are soils with pale grayish or light brownish surface soils and textural B horizons closely related in color to the surface soil. They are usually calcareous in the B horizon, and frequently also in the surface soil. They quite often have a cemented calcium carbonate hardpan at shallow to moderate depths below the B horizon. The B horizon in the Sierozen Soils in this sub-basin is usually weakly developed and difficult to identify. In mountainous areas the Sierozems may be underlain by bedrock at moderate depths. These soils are found in a semi-arid cool climate, with an average annual precipitation of about eight to 10 inches, and mostly at elevations below 6,000 feet.

Solonetz (Symbol: Y)

These are imperfectly drained soils with a very few inches of light grayish or brownish surface soil underlain by a hard columnar fine-textured horizon that is high in exchangeable sodium. They occuron floodplains, terraces, and some alluvial fans, usually as small areas associated with saline-alkali Alluvial Soils, Humic Gley Soils, and Sierozems Soils.

Mapping Units

Mapping units on the generalized soil survey map of the Pine Valley Sub-Basin are associations of phases of Great Soil Groups that reflect characteristics of soils significant to use and management. Each mapping unit symbol includes the designation of approximate composition for each Great Soil Group that comprises the association. Example: $\frac{\text{B3-R10-S8}}{\text{60-20-20}}$

SOILS TABLES

The following tables, 4 and 5, show the general soil characteristics for each great soil group phase that was mapped in the sub-basin.

Table 4. -- Soil characteristics, Pine Valley Sub-Basin

Soil Phase	Depth	Texture		Slope range %	Erosion	Salt & Alkali	Drainage	Remarks
		Surface	Subsoil					
A5	Deep	Medium	Medium	0-2	Slight	None to slight	Mod. well to well	20% seedable, 10% overflowed, some gullying
A6	Deep	Medium to moderately fine	Medium to moderately fine	0-2	Slight	Mod. to strong	Imperfect to poor	
A13	Deep	Medium to moderately fine	Medium to moderately fine	0-2	Slight	Mod. to strong	Imperfect to moderately well	Small areas of cropland
B3	Moderately deep to deep	Medium, stony & very stony medium	Medium, moderately fine to fine	4-30	Slight 10% mod.	None	Well	25-30% stony soils 10% deep (over 36")
B4	Deep	Stony medium moderately fine	Moderately fine to fine	20-40	Slight 10% mod.	None	Well	5% Chestnut, 5% Sierozem
C1	Moderately deep to deep	Stony medium and medium	Medium to moderately fine	30-50	Slight 15% mod.	None	Well	10% very stony, 10% deep Chestnut soils
G1	Moderately deep over pan	Medium and gravelly medium	Medium and gravelly medium	3-10	Slight 20% mod. 10% sev.	None	Well	40% seedable 10% stony soils
G2	Moderately deep	Medium and gravelly medium	Medium and gravelly medium	20-40	Slight 20% mod.	None	Well	10% stony soils
G3	Shallow	Gravelly and stony medium	Gravelly and stony medium	10-30	Moderate 10% sev.	None	Well	
H2	Deep	Medium	Medium	0-2	Slight	None	Imperfect to poor	

Continued

Table 4. -- Soil characteristics, Pine Valley Sub-Basin--Continued

Soil Phase	Depth	Texture		Slope range %	Erosion	Salt & Alkali	Drainage	Remarks
		Surface	Subsoil					
H9	Deep	Fine	Fine	0-3	Slight	None to slight	Imperfect to poor	Overflowed, 15% nonsaline alkali, 15% Calcium Carbonate Solonchak
L1	Shallow over bedrock	Stony and rocky medium		50-70	Slight 20% mod.	None	Excessive	
L4	Shallow over bedrock	Stony and gravelly medium		30-60	Slight	None	Excessive	
R10	Deep	Gravelly and stony medium	Medium	40-60	Slight 20% mod.	None	Somewhat excessive	
R11	Deep	Stony medium	Medium	40-60	Slight 10% mod.	None	Somewhat excessive	10% rock outcrop and very stony
S8	Moderately deep	Gravelly medium	Gravelly medium	20-40	Moderate	None	Well	10% stony soils
S9	Moderately deep	Medium	Medium	10-30	Slight	None	Well	10% mod. deep gravelly medium Sierozem, 10% deep Sierozem
S10	Moderately deep over hardpan	Medium	Moderately fine	10-30	Slight 15% mod.	None	Well	50% seedable
Y1	Deep	Medium and moderately fine	Moderately fine to fine	0-3%	Slight 5% sev.	Moderate to strong	Imperfect to mod. well	

Source: Humboldt River Basin Field Party

Table 5. -- Interpreted soil characteristics, Pine Valley Sub-Basin

Soil Phase	Precip. zone (inches)	Erosion hazard	AWHC 1/ (inches)	Soil Hydro-logic Group	Capa-bility subclass	Major land use	Dominant vegetation
A5	8-12	Slight	9	C	IIw VIc	Irrigated crops and range	Shadscale - budsage - greasewood - grass
A6	8-12	Slight	12	D	VIIs	Range	Greasewood - saltgrass - rabbitbrush - saltgrass
A13	8-10	Slight	12	D	IVw	Range	Greasewood - saltgrass
B3	8-12	Moderate	8	C	VIc VIIc	Range	Big sage - grass
B4	8-14	Slight	6-8	C	VIIs	Range	Big sage - grass
C1	8-18	Moderate	6	C	VIIe	Range	Big sage - bitterbrush, grass
G1	8-12	Moderate	4-6	D	VIc	Range	Big sage - grass
G2	8-12	Slight	4-6	D	VIIe	Range	Big sage - grass, juniper - grass
G3	8-12	Slight	2-4	D	VIIs	Range and woodland	Big sage - grass, juniper - grass
H2	8-12	Slight	12	B	IIw	Meadow, hayland and pasture	Meadow grass
H9	8-10	Slight	8-10	D	IVw	Range and meadow hayland	Rabbitbrush - giant wildrye rabbitbrush - greasewood - saltgrass
L1	8-18	Moderate	1-5	D	VIIs	Range and watershed	Low sage - grass
L4	8-14	Slight	2-4	D	VIs	Range and woodland	Big sage - grass, juniper - grass
R10	8-14	Moderate	6-8	C	VIIe	Range	Big sage - grass, juniper
R11	10-18	Moderate	6-8	C	VIIe	Range	Big sage - grass
S8	8-12	Slight	4-6	D	VIIe	Range	Big sage - grass
S9	8-12	Slight	4-6	D	VIc VIIe	Range, 30% seedable	Big sage - grass
S10	8-12	Moderate	6-8	C	VIc	Range	Big sage - grass
Y1	8-10	Slight	12	D	VIIs	Range, small amounts cropland	Greasewood - saltgrass

1/ Available water holding capacity.

Source: Humboldt River Basin Field Party.

DEFINITIONS

HYDROLOGIC SOIL GROUP

Watershed soil determinations are used in the preparation of hydrologic soil-cover complexes, which in turn are used in estimating direct runoff. Four major soil groups are used. The soils are classified on the basis of intake of water at the end of long-duration storms occurring after prior wetting and opportunity for swelling and without the protective effects of vegetation.

<u>Group A</u> - Soils having high infiltration rates even when thoroughly wetted, consisting chiefly of deep, well to excessively well drained sands and/or gravel. These soils have a high rate of water transmission and would result in a low runoff potential.

<u>Group B</u> - Soils having moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately course textures. These soils have a moderate rate of water transmission.

<u>Group C</u> - Soils having slow infiltration rates when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water, or (2) soils with moderately fine to fine texture and slow infiltration rate. These soils have a slow rate of water transmission.

<u>Group D</u> - Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clay soils with a high swelling potential; (2) soils with a high permanent water table; (3) soils with a claypan or clay layer at or near the surface; and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

LAND USE CAPABILITY CLASSES AND SUBCLASSES

The capability classification is a practical grouping of soils. Soils and climate are considered together as they influence use, management, and production on the farm or ranch.

The classification contains two general divisions: (1) land suited for cultivation and other uses; and (2) land limited in use and generally not suited for cultivation. Each of these broad divisions has four classes which are shown by a number. The hazards and limitations in use increase as the class number increases. Class I has few hazards or limitations, or none, whereas Class VIII has a great many.

Capability classes are divided into subclasses. These show the principal kinds of conservation problems involved. The subclasses are "e" for erosion, "w" for wetness, "s" for soil, and "c" for climate.

Capability classes and subclasses, in turn, may be divided into capability units. A capability unit contains soils that are nearly alike in plant growth and in management needs.

Land Suited for Cultivation and Other Uses

Class I — Soils in Class I have few or no limitations or hazards. They may be used safely for cultivated crops, pasture, range, woodland or wildlife.

Class II — Soils in Class II have few limitations or hazards. Simple conservation practices are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class III — Soils in Class III have more limitations and hazards than those in Class II. They require more difficult or complex conservation practices when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class IV — Soils in Class IV have greater limitations and hazards than Class III. Still more difficult or complex measures are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class V — Soils in Class V have little or no erosion hazard but have other limitations that prevent normal tillage for cultivated crops. They are suited to pasture, woodland, range, or wildlife.

Class VI — Soils in Class VI have severe limitations or hazards that make them generally unsuited for cultivation. They are suited largely to pasture, range, woodland, or wildlife.

Class VII — Soils in Class VII have very severe limitations or hazards that make them generally unsuited for cultivation. They are suited to grazing, woodland, or wildlife.

Class VIII — Soils and land forms in Class VIII have limitations and hazards that prevent their use for cultivated crops, pasture, range, or woodland. They may be used for recreation, wildlife, or water supply.

ANNUAL WATER BALANCE STUDY - 80% FREQUENCY

Annual Water Balance is defined for the studies as the portion of the hydrologic cycle which starts with precipitation on the watershed, and ends with runoff (both surface and subsurface), after subtracting water uses and losses.

Studies were made to find answers to the following questions:

1. What is the gross water yield of the watersheds in the sub-basin? This gross water yield is considered to be the available water prior to irrigation and phreatophytic use.

2. What is the approximate magnitude of water use and loss by each of the major ground cover types?

3. Where are the water-yielding areas in the sub-basin and in each watershed?

4. Can vegetal manipulation be used to increase water supply for beneficial use?

Calculation of the annual water balance studies furnished the following information to the above questions:

1. The 80 percent gross water yield from the watersheds in Pine Valley was estimated to be 20,000 acre-feet.

2. Estimated water use and outflow is as follows: Irrigated crops 4,550 acre-feet; phreatophytes 10,450 acre-feet; and outflow to the Humboldt River 5,000 acre-feet.

3. The highest water-yielding area is the Roberts Mountains. The springs on Hot Creek, heading in the Sulphur Springs Range, furnish a continuous flow of four to five cubic feet per second to that stream.

4. Nonbeneficial phreatophytes above the major irrigated land use an estimated 8,000 acre-feet of ground water annually. A portion of this water could be put to beneficial use if such plants were controlled.

The annual water balance was calculated for an 80 percent frequency (expected eight out of 10 years). This frequency was used because such a water supply would be the quantity needed to justify land and irrigation improvements on ranches growing high-yielding crops.

Values obtained using this procedure are approximations. Accuracy would depend on the reliability of the basic soils, vegetation, and hydrologic data used, but would probably be in the range of 60 to 90 percent. Water yield data are not available on the watersheds of Pine Valley. U.S. Geological Survey streamflow records on Pine Creek were used to estimate the 80 percent frequency flow into the Humboldt River.

It was necessary to divide the sub-basin into five watershed areas in order to obtain a

more accurate estimate of the water uses and losses. As shown on figure 1, these watersheds are: (1) Henderson Creek; (2) Denay Creek; (3) Upper Pine Creek; (4) Middle Pine Creek; and (5) Lower Pine Creek. Table 6 is a summary of the water balance studies for these watershed areas. The values in the tables show acres and runoff by elevation zones. Also included is the gross water yield for each watershed.

Table 7 shows the annual streamflow at the Pine Creek gaging station, both actual and calculated values, for the years 1909 through 1960.

Table 6. -- Summary of Water Balance Studies by elevation zones for watersheds in the Pine Valley Sub-Basin for an 80 percent frequency

Elevation zone (feet)	Henderson Creek			Denay Creek			Upper Pine Creek		
		Runoff			Runoff			Runoff	
	Acres	acre-feet	in./ac.	Acres	acre-feet	in./ac.	Acres	acre-feet	in./ac.
9-10,000	1,400	540	4.63	-------	-----	----	-------	-----	---
8- 9,000	7,580	1,340	2.12	1,000	170	2.04	260	70	3.23
7- 8,000	30,350	3,140	1.24	22,670	1,890	1.00	12,530	1,800	1.72
6- 7,000	83,280	440	.06	66,670	1,110	.20	46,450	2,200	.57
5- 6,000	34,520	-2,210	----	64,900	-2,050	----	102,780	-5,390	----
Watershed Total	157,130	3,250	.25	155,240	1,120	.09	162,020	-1,320	----
Gross water yield	-------	5,920	----	-------	3,030	----	-------	4,050	----

Elevation zone (feet)	Middle Pine Creek (Hot Creek)			Lower Pine Creek (Trout Cr.)		
		Runoff			Runoff	
	Acres	acre-feet	in./ac.	Acres	acre-feet	in./ac.
9-10,000	-------	-----	----	-------	-----	----
8- 9,000	560	170	3.64	720	200	3.33
7- 8,000	8,260	1,260	1.83	5,410	940	2.08
6- 7,000	28,330	1,090	.46	35,540	720	.24
Hot Creek		2,920	----			
5- 6,000	60,930	-3,630	----	41,880	-1,470	----
4- 5,000	-------	-----	----	2,450	- 250	----
Watershed Total	98,080	1,810	.22	86,000	140	.02
Gross water yield	-------	5,320	----	-------	1,670	----

Source: Humboldt River Basin Field Party

Table 7. -- Estimated annual streamflow at the Pine Creek gage and estimated available water above irrigation, Pine Valley Sub-Basin

Year	Annual streamflow (acre-feet) 1/		Available water above irr. (acre-feet) 2/
1909	9,600		14,700
10	30,000		36,000
11	5,200		9,600
12	11,000		16,300
13	7,460	3/	12,200
14	26,600	3/	32,600
15	3,500		7,600
16	6,500		11,100
17	14,500		20,400
18	3,200		7,200
19	6,500		11,100
1920	4,600		8,900
21	24,000		30,000
22	12,000		17,500
23	7,700		12,500
24	4,200		8,400
25	10,000		15,200
26	3,200		7,200
27	7,300		12,000
28	4,600		8,900
29	4,000		8,200
1930	4,500		8,700
31	1,500		5,500
32	12,500		18,100
33	4,800		9,100
34	1,500		5,500
35	5,600		10,000
36	9,600		14,700
37	6,000		10,500
38	6,400		11,000
39	5,800		10,200
1940	5,600		10,000
41	10,000		15,200
42	23,000		29,000
43	12,000		17,500
44	11,000		16,300
45	26,000		32,000
46	14,000		19,800
47	7,860	3/	12,700
48	5,440	3/	9,900
49	9,110	3/	14,000
1950	6,970	3/	11,600
51	10,850	3/	16,100
52	28,800	3/	34,800
53	4,600	3/	8,900
54	3,390	3/	7,500
55	3,870	3/	8,000
56	9,740	3/	14,800
57	4,220	3/	8,400
58	6,400	3/	11,000
59	2,200		6,200
1960	3,300		7,400
80%	4,100		8,400
50%	7,000		12,000

1/ At Pine Creek gage.

2/ Annual streamflow at Pine Creek gage plus estimated irrigated crop use.

3/ U. S. Geological Survey streamgage records - below all irrigated diversions in Pine Valley. All other values were interpolated and adjusted from frequency curves of streamflow on Pine Creek, Humboldt River at Palisade, and South Fork of Humboldt River near Elko.

Source: Humboldt River Basin Field Party

CHRONOLOGY OF FLOODS

An extensive search for material on floods, a little-known facet of the sub-basin history, was made in the newspaper files for Unionville, Winnemucca, Eureka, Elko, Wells, and Reno, supplemented by interviews with old residents. Reference was also made to all available stream flow records for the area. By this means, it has been possible to compile a rather complete list of the major floods and high water periods in the Pine Valley Sub-Basin, with resultant damages wherever known. A tabular condensation of this record is included in this appendix, table 8.

Table 8. -- Chronology of flood years, 1861-1962, Pine Valley Sub-Basin

Month and year	Type	Damage and losses	Remarks
July 24, 1874	Dry-mantle	Not known for the sub-basin	Series of rainstorms on thinly-covered watershed. South of the sub-basin at Eureka, five lives lost; 30 buildings wrecked or carried away; overall damage $100,000.
July 24, 1876	Dry-mantle	Not known for the sub-basin	Series of rainstorms on thinly-covered watershed. No life or property loss at Eureka. Inhabitants had to flee to higher ground.
August 15, 1878	Dry-mantle	Not known for the sub-basin	Series of rainstorms on thinly-covered watershed. No lives lost; property damage $75,000 at Eureka.
Jan. 13-May 25, 1881	Wet-mantle	Range and watershed erosion damage. Floodwater and sediment damage to irrigation structures and ditches, railroads, roads, ranch buildings and haystacks	Prolonged rain on melting snow, or runoff over frozen range and meadow lands.
May 1884	Wet-mantle	Three-hour train delay by minor washout on Henderson Creek, at Pine Station; and washouts at Bradley's Flat and Raines Station on lower Pine Creek.	Melting snow and rains during May and June caused damage throughout northern Nevada. During this period the waters of the Humboldt and Carson Sinks met for the first time in recorded History.
Mar. 7-June 1890	Wet-mantle	Two lives lost. Heavy livestock loss. Erosion, floodwater, and sediment damage.	Melting of enormous snow masses caused heavy floods. No bridge washouts.

Continued

Table 8. -- Chronology of flood years, 1861-1962, Pine Valley Sub-Basin -- Continued

Month and year	Type	Damage and losses	Remarks
Feb. 18-Mar. 15, 1910	Wet-mantle	Thirty miles of railroad destroyed. Road and railroad bridges washed away; bridge approaches destroyed. Passenger and freight trains stranded. Extensive gullying; formation of present deep gullies on Pine Creek. The head-cutting extended upstream approximately four miles from the confluence of Pine Creek with the Humboldt to the old Jewell Ranch.	Deep snow over entire area. Lower half of Pine Valley from Blackburn Station (Trading Post) northward to the Humboldt covered with water. Palisade cut off from Pine Valley. Western Pacific grade on Humboldt between Palisade and Battle Mountain so badly washed the Southern Pacific route was used by W.P. for months afterward. Eureka & Palisade R.R. sold at auction, account of extensive flood damage. Travel suspended to Eureka except by roundabout 115 mile automobile route through Ely and Elko.
Jan.-Feb. 1914	Wet-mantle	Railroad tracks and bridges washed out; three railroad bridges and 60 foot trestle over lower Pine Creek. Deepening of 1910 gully pattern on Pine Creek.	1,000 c.f.s. (calculated) at Pine Creek gaging station, Jan. 25 and 26, 1914. Average daily discharge 14.6 c.f.s. Train service between Palisade and Eureka suspended for three weeks.
Feb.-March 1917	Wet-mantle	Railroad grade washouts. Bridges over side streams washed out. Gullying and erosion. Irrigation structures, ditches, ranch buildings, etc.	Train service suspended for three weeks (Eureka Nevada R.R.) between Eureka and Palisade; once for one week, and once for two weeks.
Feb. 13-Mar. 4, 1921	Wet-mantle	600 feet of railroad track, several bridges in Pine Creek Narrows washed out. Damage to meadowland. Gullying, erosion, and channel cutting. Irrigation structures, ditches, ranch buildings, etc.	Prolonged rain on melting snow, or runoff over frozen range and meadow lands. Approximately one week's suspension of train service (E.N.R.R.)

Continued

Table 8. -- Chronology of flood years, 1861-1962, Pine Valley Sub-Basin -- Continued

Month and year	Type	Damage and losses	Remarks
April 1942	Wet-mantle	General erosion, floodwater, and sedimentation damage in Pine Valley.	Prolonged warm rains on heavy snow pack on upper Humboldt tributaries, including Pine Creek; no discharge records available for Pine Creek. April 7, flood peak.
Jan. 22-26, 1943	Wet-mantle	Sheet erosion, gullying, channel cutting; floodwater and sediment damage to irrigation structures and ditches, roads, bridges, ranch buildings and haystacks.	Prolonged rain on melting snow, or run-off over frozen range and meadow lands.
Mar. - Apr., 1952	Wet-mantle	Sheet and gully erosion, channel and head cutting. Water standing on land. Bridges, roads, irrigation structures and ditches, ranch buildings washed out.	Immense snow accumulation. On Mar. 21, 1952, 13 c.f.s.; Mar. 27, 424 c.f.s. water flowed around Pine Creek gage, using rating curve, maximum at 7:00 P.M. that day, 1,010 c.f.s. High water continued until first week in May; May 5, 158 c.f.s.; May 9, 94 c.f.s.
Aug. 6-28, 1961	Dry-mantle	Localized damage from overland flows. Sheet and gully erosion, road and highway washins and washouts.	Series of rainstorms on poorly vegetated watershed range and timberlands.
Feb. 11-12, 1962	Wet-mantle	Pine Creek on Feb. 11-12 took out an irrigation diversion below the Narrows, and washed out most of the renmants of the old Eureka & Palisade railroad trestles, in and above the Narrows, just as it had done in the 1910, 1914, and 1917 floods.	Six days of intermittent snow, rain, and some hail in the middle and upper Humboldt Basin, from Battle Mt. eastward, effectively broke the 3 year (1959-61) drought in the basin. These storms produced floods and high water in this same area, beginning on Feb. 9 and continuing through Feb. 13.

Continued

Table 8. -- Chronology of flood years, 1861-1962, Pine Valley Sub-Basin -- Continued

Month and year	Type	Damage and losses	Remarks
Feb. 11-12, 1962 (Continued)		The deeply eroded Pine Creek main channel described in the sections on the earlier floods was gouged wider and deeper.	The floods were the result of rain on the snow pack and frozen ground at elevations around 6,500 feet or below, almost approximating dry-mantle flood conditions at first because of the frozen ground. Subsequent melting of the frost layer caused wet-mantle conditions to develop. The flood peak in Pine Valley came on Feb. 11-12 (3,460 c.f.s., peak flow).
High-water year (non-flood producing) Mar. - Apr. 1907	Spring snow-melt	General flood damages. Train movements on E&PRR delayed on account of trestle wash-out, 16 miles south of Palisade.	No extensive flooding

Source: Humboldt River Basin Field Party

Effects of Variable Water Supplies on Value of Hay Produced and of Cattle and Calves Marketed

An economic appraisal of the value of irrigation water requires the establishment of an estimate of crop yield response to variations in water supply. The problem is complex. Water-holding capacities of the different soils, the soil-moisture levels required for production of the different crops, ground-water levels, irrigation methods used, physical features and practical problems involved in operation of distribution systems, and variations in climatic factors result in wide variations in the amount of water required at ranch headgates to produce crops. Based on observations and investigations, the impact of drought and conversely the production function for water involve reduction in per acre yields, reduction in harvested acreage, and adjustments in cropping patterns.

Adequate historical data on the quantity of water used, on a ranch basis, in producing crops in Pine Valley are not available. The area is subject to extreme annual variations in the total quantity of stream runoff. Frequently, channels and water-control structures are inadequate to control the high seasonal flows that occur from February through May.

Streamflow records constitute the principal source of reliable water supply information, although continuous records are not available. The U.S. Geological Survey has maintained an intermittent record of runoff in Pine Creek. Using the partial record available on Pine Creek, and correlating this record with records of streamflow of the Humboldt River at Palisade and South Fork near Elko, estimates of the total annual flow of Pine Creek, at the gage, for the period 1909 to 1960 were developed by the Field Party. This gage is located below the irrigated land in Pine Valley, and therefore is not a record of the quantity of water available for irrigation. It is, however, useful as an indicator of the annual variations in total supply of water available to ranchers in the valley.

Historical records of production for agricultural commodities in Pine Valley are limited. Production records for the principal agricultural crops harvested are available for Eureka County by five-year intervals from the U.S. Censuses of Agriculture. Acreages of land irrigated in Pine Valley are available for 10-year intervals from the U.S. Census of Irrigation. Annual estimates of production of the principal crops, livestock, and livestock products are available from the Statistical Reporting Service. These are available on a State basis only.

In order to determine the correlation between estimated total annual flow of Pine Creek at the gage, hay production, and cattle and calves marketed, a procedure was developed wherein water supply was related to crop and cattle production.

Annual variations in stream runoff at the Pine Creek gage are great. The estimated annual runoff for the highest year in the period 1912-61 was about 19 times the annual runoff for the lowest year. To modify the annual fluctuations, a three-year moving average was computed (see table 10).

Over a period of years variations in prices received for agricultural commodities are frequently large, and tend to obscure other fundamental relationships. To eliminate this

variable, a constant price per ton of all hay and per hundred weight of cattle and calves was applied to estimates of physical production which occurred during the study period. Three-year moving averages were also computed for the value of hay produced and for the value of cattle and calves marketed (see tables 11 and 12).

Hay production is affected by many additional factors, such as antecedent moisture conditions and water supplies, seasonal distribution of annual runoff, temperature, wind, disease, insects, rodents, fertilization, stand density, and management decisions as to when to harvest and whether to cut the hay or harvest it by grazing livestock.

To modify the effect that factors other than water supply have on hay production, the 50 years included in the study period were arrayed in order of magnitude of runoff, thus revealing more accurately the effect of water supplies on hay production. The array of water years with corresponding hay production was then divided into five 10-year groups, and the means for each of the groups were computed (see table 13). Means for both the water and hay groups were plotted, and a curve was visually fitted to the plotted points (see figure 3).

Efficiency of water use is associated with the status of land and irrigation development and the level of technology. To roughly indicate the impact of land and irrigation system development and technological advances which have occurred, the 50 years in the study period were divided into two periods, 1912-36 and 1937-61. Years within each of the periods were arrayed in order of magnitude of runoff and were then divided into five 5-year groups. Means were computed for both water and hay production for each group in each period (see tables 14 and 15). The means of the groups were plotted for each period and a curve was visually fitted to the plotted points for each period (see figure 3).

Table 9. -- Grazing use of Federal and intermingled private range, by months for ranches 1/ headquartered in Pine Valley Sub-basin, Nevada, 1960

Month	Cattle	Sheep	Horses	Total
	AUM	AUM	AUM	AUM
January	1,150	-----	175	1,325
February	400	-----	175	575
March	1,197	-----	190	1,387
April	8,227	1,500	265	9,992
May	9,638	1,500	290	11,428
June	9,648	1,500	165	11,313
July	9,026	1,100	245	10,371
August	9,293	1,100	245	10,638
September	7,828	1,300	240	9,368
October	5,438	350	240	6,028
November	2,292	-----	200	2,492
December	1,250	-----	175	1,425
Total	65,387	8,350	2,605	76,342
Percentage from Federal range	80	100	85	83

1/ Includes grazing privileges in the Elko and Battle Mountain Districts of B.L.M. held by ranchers headquartered in Pine Valley Sub-basin. The area grazed includes areas outside the sub-basin boundary as well as areas within the sub-basin.

Source: Compiled from Bureau of Land Management records.

Table 10. -- Estimated annual streamflow and 3-year moving average, Pine Valley, Nevada, 1912-61

Year	Total annual streamflow 1/ Acre-feet	3-year moving average Total acre-feet	3-year moving average Average acre-feet	Year	Total annual streamflow 1/ Acre-feet	3-year moving average Total acre-feet	3-year moving average Average acre-feet
1912	11,000	------	------	1938	6,400	24,600	6,150
13	2/ 7,460	42,620	10,655	39	5,800	23,600	5,900
14	2/ 26,600	64,160	16,040	1940	5,600	27,000	6,750
1915	3,500	40,100	10,025	41	10,000	46,600	11,650
16	6,500	21,000	5,250	42	23,000	68,000	17,000
17	14,500	38,700	9,675	43	12,000	58,000	14,500
18	3,200	27,400	6,850	44	11,000	60,000	15,000
19	6,500	20,800	5,200	1945	26,000	77,000	19,250
1920	4,600	39,700	9,925	46	14,000	61,860	15,465
21	24,000	64,600	16,150	47	2/ 7,860	35,160	8,790
22	12,000	55,700	13,925	48	2/ 5,440	27,850	6,962
23	7,700	31,600	7,900	49	2/ 9,110	30,630	7,658
24	4,200	26,100	6,525	1950	2/ 6,970	33,900	8,475
1925	10,000	27,400	6,850	51	2/ 10,850	57,470	14,365
26	3,200	23,700	5,925	52	2/ 28,800	73,050	18,262
27	7,300	22,400	5,600	53	2/ 4,600	41,390	10,348
28	4,600	20,500	5,125	54	2/ 3,390	15,250	3,812
29	4,000	17,100	4,275	1955	2/ 3,870	20,870	5,218
1930	4,500	14,500	3,625	56	2/ 9,740	27,570	6,892
31	1,500	20,000	5,000	57	2/ 4,220	24,580	6,145
32	12,500	31,300	7,825	58	2/ 6,400	19,220	4,805
33	4,800	23,600	5,900	59	2,200	14,100	3,525
34	1,500	13,400	3,350	1960	3,300	11,300	2,825
1935	5,600	22,300	5,575	61	2,500	------	------
36	9,600	30,800	7,700				
37	6,000	28,000	7,000				

1/ At Pine Creek gage below all irrigation diversions.
2/ USGS gage records.

Source: Humboldt River Basin Field Party from USGS data.

Table 11. -- Estimated hay production and value at actual and constant price, Pine Valley, Nevada, 1912-61

Year	Hay production: Tons	Hay production: 3-year moving average: Total	Hay production: 3-year moving average: Average	Value of hay produced: Actual Price	Value of hay produced: Constant price $22.00 per ton: Annual	Value of hay produced: Constant price $22.00 per ton: 3-year moving average 1/
		Tons	Tons	1,000 dols.	1,000 dols.	1,000 dols.
1912	4,892	------	-----	45	108	---
13	4,976	20,313	5,078	47	109	112
14	5,469	20,510	5,128	46	120	113
1915	4,596	19,385	4,846	42	101	107
16	4,724	19,245	4,811	65	104	106
17	5,201	19,774	4,944	81	114	109
18	4,648	19,256	4,814	82	102	106
19	4,759	20,485	5,121	98	105	113
1920	6,319	23,269	5,817	95	139	128
21	5,872	24,509	6,127	56	129	135
22	6,446	24,402	6,100	63	142	134
23	5,638	23,452	5,863	64	124	129
24	5,730	23,495	5,874	86	126	129
1925	6,397	24,333	6,083	63	141	134
26	5,809	23,292	5,823	54	128	128
27	5,277	21,616	5,404	49	116	119
28	5,253	20,234	5,058	49	116	111
29	4,451	18,879	4,720	52	98	104
1930	4,724	15,799	3,950	41	104	87
31	1,900	12,764	3,191	18	42	70
32	4,240	13,402	3,350	20	93	74
33	3,022	12,356	3,089	17	66	68
34	2,072	11,939	2,985	19	46	66
1935	4,773	17,790	4,448	34	105	98
36	6,172	24,699	6,175	54	136	136
1937	7,582	29,556	7,389	64	167	163
38	8,220	32,640	8,160	54	181	180
39	8,618	34,721	8,680	89	190	191
1940	9,265	36,978	9,244	84	204	203
41	9,830	37,384	9,346	104	216	206
42	8,459	34,789	8,697	135	186	191
43	8,041	32,477	8,119	182	177	179
44	7,936	31,985	7,996	179	176	176
1945	8,072	32,996	8,249	171	178	181
46	8,916	33,985	8,496	224	196	187
47	8,081	32,633	8,158	175	178	179
48	7,555	30,385	7,596	212	166	167
49	7,194	29,112	7,278	148	158	160
1950	7,169	28,563	7,141	148	158	157
51	7,031	28,783	7,196	202	155	158
52	7,552	29,168	7,292	194	166	160
53	7,033	26,407	6,602	144	155	145
54	4,789	21,094	5,274	113	105	116
1955	4,483	21,079	5,270	112	99	116
56	7,324	25,792	6,448	146	161	142
57	6,661	27,406	6,851	117	147	151
58	6,760	24,237	6,059	122	150	133
59	4,056	19,801	4,950	97	89	109
1960	4,929	18,814	4,703	128	108	103
61	4,900	------	-----	---	---	---

1/ Weighted 1, 2, 1 recorded center year.
Source: Humboldt River Basin Field Party from U.S. Census of Agriculture and U.S. Statistical Reporting Service.

Table 12. -- Estimated January 1 inventory of all cattle and total weight of cattle and calves marketed during the year, Pine Valley, Nevada, 1924-61

Year	January 1 inventory all cattle and calves		Marketings during year				
			Total Weight	Value sales		3-year moving average value constant price 1/	
	Head	Animal units		Actual price	Constant price 2/	Total	Average
			1,000 lbs.	1,000 dols.	1,000 dols.	1,000 dols.	1,000 dols.
1924	8,600	6,680	2,083	126	412	-----	---
25	7,920	6,280	1,887	117	374	1,496	374
26	6,880	5,480	1,696	119	336	1,322	331
27	5,960	4,760	1,394	106	276	1,116	279
28	5,200	4,160	1,152	111	228	952	238
29	4,440	3,600	1,109	104	220	819	205
1930	3,840	3,120	764	60	151	668	167
31	4,080	3,320	739	41	146	577	144
32	4,400	3,600	676	31	134	571	143
33	4,840	4,000	791	29	157	689	172
34	5,400	4,480	1,216	44	241	860	215
1935	5,560	4,600	1,114	70	221	949	237
36	6,400	5,200	1,344	79	266	1,049	262
37	7,360	5,880	1,496	102	296	1,200	300
38	8,560	6,640	1,728	110	342	1,339	335
39	9,520	7,280	1,814	127	359	1,511	378
1940	9,960	7,720	2,278	172	451	1,645	411
41	9,880	7,680	1,860	168	384	1,627	407
42	9,720	7,640	1,976	214	408	1,615	404
43	9,520	7,600	2,009	240	415	1,730	432
44	9,280	7,520	2,381	240	492	1,847	462
1945	8,560	7,120	2,167	262	448	1,808	452
46	8,560	7,120	2,033	284	420	1,722	430
47	8,520	7,120	2,098	360	434	1,738	434
48	8,400	7,040	2,176	480	450	1,806	452
49	8,360	7,040	2,285	458	472	1,869	467
1950	8,200	7,000	2,296	520	475	1,891	473
51	8,400	7,000	2,268	698	469	1,909	477
52	8,400	7,200	2,442	616	496	1,974	494
53	8,640	7,280	2,484	397	513	1,984	496
54	8,320	7,120	2,236	350	462	1,895	474
1955	7,920	6,880	2,218	332	458	1,829	457
56	7,760	6,680	2,180	316	451	1,828	457
57	7,600	6,440	2,258	424	468	1,764	441
58	7,160	6,000	1,822	448	377	1,610	402
59	7,200	5,960	1,877	464	388	1,604	401
1960	7,160	5,880	2,180	452	451	-----	---
61	6,720	5,640	-----	---	---	-----	---

1/ Weighted 1, 2, 1, recorded center year.
2/ Weighted average price per cwt.; 1924-40, $19.80; 1941-61, $20.67. Calves constituted a larger percentage of animals marketed during the later period.
Source: Humboldt River Basin Field Party from U.S. Census of Agriculture and U.S. Statistical Reporting Service.

Table 13. -- Estimated annual streamflow and hay production, by 10-year groups, arranged in order of magnitude of annual streamflow, Pine Valley, Nevada, 1912-61.

Order	Year	Annual streamflow 1/	Hay production	
			Tons	Value-constant price 2/
		Acre-feet		1,000 dollars
1	1934	1,500	2,072	46
2	1931	1,500	1,900	42
3	1959	2,200	4,056	89
4	1961	2,500	4,900	108
5	1918	3,200	4,648	102
6	1926	3,200	5,809	128
7	1960	3,300	4,929	108
8	1954	3,390	4,789	105
9	1915	3,500	4,596	101
10	1955	3,870	4,483	99
Total		28,160	42,182	928
Mean		2,816	4,218	93
11	1929	4,000	4,451	98
12	1924	4,200	5,730	126
13	1957	4,200	6,661	147
14	1930	4,500	4,724	104
15	1953	4,600	7,033	155
16	1920	4,600	6,319	139
17	1928	4,600	5,253	116
18	1933	4,800	3,022	66
19	1948	5,440	7,555	166
20	1935	5,600	4,773	105
Total		46,540	55,521	1,222
Mean		4,654	5,552	122
21	1940	5,600	9,265	204
22	1939	5,800	8,618	190
23	1937	6,000	7,582	167
24	1938	6,400	8,220	181
25	1958	6,400	6,760	150
26	1916	6,500	4,724	104
27	1919	6,500	4,759	105
28	1950	6,970	7,169	158
29	1927	7,300	5,277	116
30	1913	7,460	4,976	109
Total		64,930	67,350	1,484
Mean		6,493	6,735	148

Continued

Table 13. -- Estimated annual streamflow and hay production, by 10-year groups, arranged in order of magnitude of annual streamflow, Pine Valley, Nevada, 1912-61 -- Continued

Order	Year	Annual streamflow 1/	Hay production	
			Tons	Value-constant price 2/
		Acre-feet		1,000 dollars
31	1923	7,700	5,638	124
32	1947	7,860	8,081	178
33	1949	9,110	7,194	158
34	1936	9,600	6,172	136
35	1956	9,740	7,324	161
36	1925	10,000	6,397	141
37	1941	10,000	9,830	216
38	1951	10,850	7,031	155
39	1912	11,000	4,892	108
40	1944	11,000	7,936	176
Total		96,860	70,495	1,553
Mean		9,686	7,050	155
41	1922	12,000	6,446	142
42	1943	12,000	8,041	177
43	1932	12,500	4,240	93
44	1946	14,000	8,916	196
45	1917	14,500	5,201	114
46	1942	23,000	8,459	186
47	1921	24,000	5,872	129
48	1945	26,000	8,072	178
49	1914	26,600	5,469	120
50	1952	28,800	7,552	166
Total		193,400	68,268	1,501
Mean		19,340	6,827	150
Grand total		429,890	303,816	6,688
Mean		8,598	6,076	134
Median		6,450		

Percent of time flow equalled or exceeded

20 percent	12,000
50 percent	6,450
80 percent	4,000
100 percent	1,500

1/ At Pine Creek gage below all irrigation diversions.
2/ $22.00 per ton.

Source: Humboldt River Basin Field Party from U.S. Geological Survey data, U.S. Census of Agriculture and U.S. Statistical Reporting Service.

Table 14. -- Estimated annual streamflow at the Pine Creek gage and hay production by 5-year groups arranged in order of magnitude, for the 1912-36 period, Pine Valley, Nevada

Order	Year 1912-36	Annual 1/ streamflow	Hay Production	Order	Year 1912-36	Annual 1/ streamflow	Hay Production
		Acre-feet	Tons			Acre-feet	Tons
1	1934	1,500	2,072	16	1913	7,460	4,976
2	1931	1,500	1,900	17	1923	7,700	5,638
3	1918	3,200	4,640	18	1936	9,600	6,172
4	1926	3,200	5,809	19	1925	10,000	6,397
5	1915	3,500	4,596	20	1912	11,000	4,892
Total		12,900	19,025	Total		45,760	28,075
Mean		2,580	3,805	Mean		9,152	5,615
6	1929	4,000	4,451	21	1922	12,000	6,446
7	1924	4,200	5,730	22	1932	12,500	4,240
8	1930	4,500	4,724	23	1917	14,500	5,201
9	1920	4,600	6,319	24	1921	24,000	5,872
10	1928	4,600	5,253	25	1914	26,600	5,469
Total		21,900	26,477	Total		89,600	27,228
Mean		4,380	5,295	Mean		17,920	5,446
11	1933	4,800	3,022	Grand Total		200,860	123,360
12	1935	5,600	4,773	Mean		8,034	4,934
13	1916	6,500	4,724	Median		6,500	
14	1919	6,500	4,759				
15	1927	7,300	5,277	Flow equalled or exceeded			
Total		30,700	22,555	20 percent of time		12,000	
Mean		6,140	4,511	50 percent of time		6,500	
				80 percent of time		4,000	
				100 percent of time		1,500	

1/ At Pine Creek gage below all irrigation diversions.
Source: Humboldt River Basin Field Party from U.S. Geological Survey data, U.S. Census of Agriculture and U.S. Statistical Reporting Service.

Table 15. -- Estimated annual streamflow at the Pine Creek gage and hay production by 5-year groups arranged in order of magnitude, for the 1937-61 period, Pine Valley, Nevada

Order	Year 1937-61	Annual 1/ streamflow	Hay Production
		Acre-feet	Tons
1	1959	2,200	4,056
2	1961	2,500	4,900
3	1960	3,300	4,929
4	1954	3,390	4,789
5	1955	3,870	4,483
Total		15,260	23,157
Mean		3,052	4,631
6	1957	4,200	6,661
7	1953	4,600	7,033
8	1948	5,440	7,555
9	1940	5,600	9,265
10	1939	5,800	8,618
Total		25,640	39,132
Mean		5,128	7,826
11	1937	6,000	7,582
12	1938	6,400	8,220
13	1958	6,400	6,760
14	1950	6,900	7,169
15	1947	7,860	8,081
Total		33,560	37,812
Mean		6,712	7,562

Order	Year 1937-61	Annual 1/ streamflow	Hay Production
		Acre-feet	Tons
16	1949	9,110	7,194
17	1956	9,740	7,324
18	1941	10,000	9,830
19	1951	10,850	7,031
20	1944	11,000	7,936
Total		50,700	39,315
Mean		10,140	7,863
21	1943	12,000	8,041
22	1946	14,000	8,916
23	1942	23,000	8,459
24	1945	26,000	8,072
25	1952	28,800	7,552
Total		103,800	41,040
Mean		20,760	8,208
Grand Total		228,960	180,456
Mean		9,158	7,218
Median		6,400	
Flow equalled or exceeded			
20 percent of time		12,000	
50 percent of time		6,400	
80 percent of time		4,200	
100 percent of time		2,200	

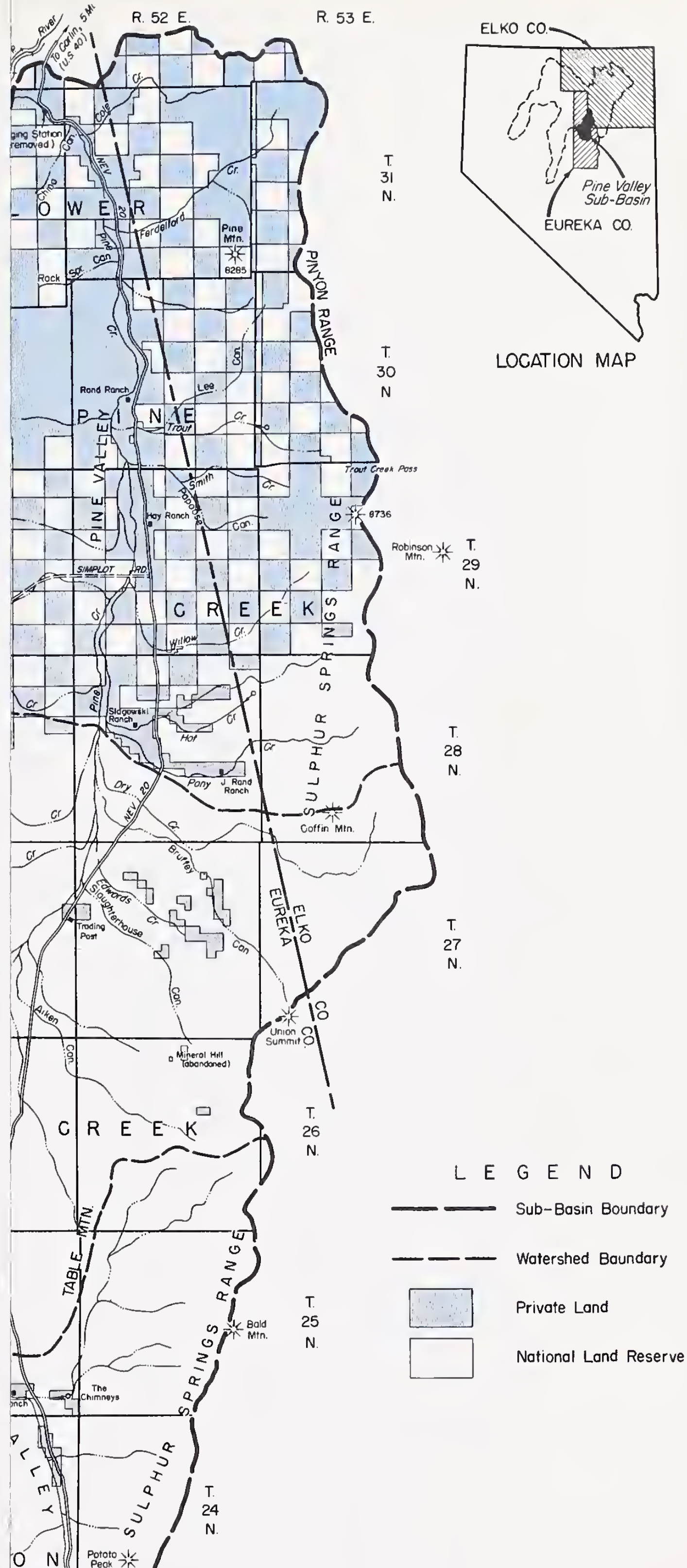
1/ At Pine Creek gage below all irrigation diversions.
Source: Humboldt River Basin Field Party from U.S. Geological Survey data, U.S. Census of Agriculture and U.S. Statistical Reporting Service

APPENDIX II

This appendix is produced in a relatively limited number of copies. It contains material germane to the Pine Valley Sub-Basin but which, because of its detailed or technical nature, is not attached to copies for general distribution.

Such material, however, has potential value as an information reservoir for technicians, administrators, and resource managers concerned with the Pine Valley Sub-Basin.

Table of Contents



LAND STATUS MAP

PINE VALLEY SUB-BASIN

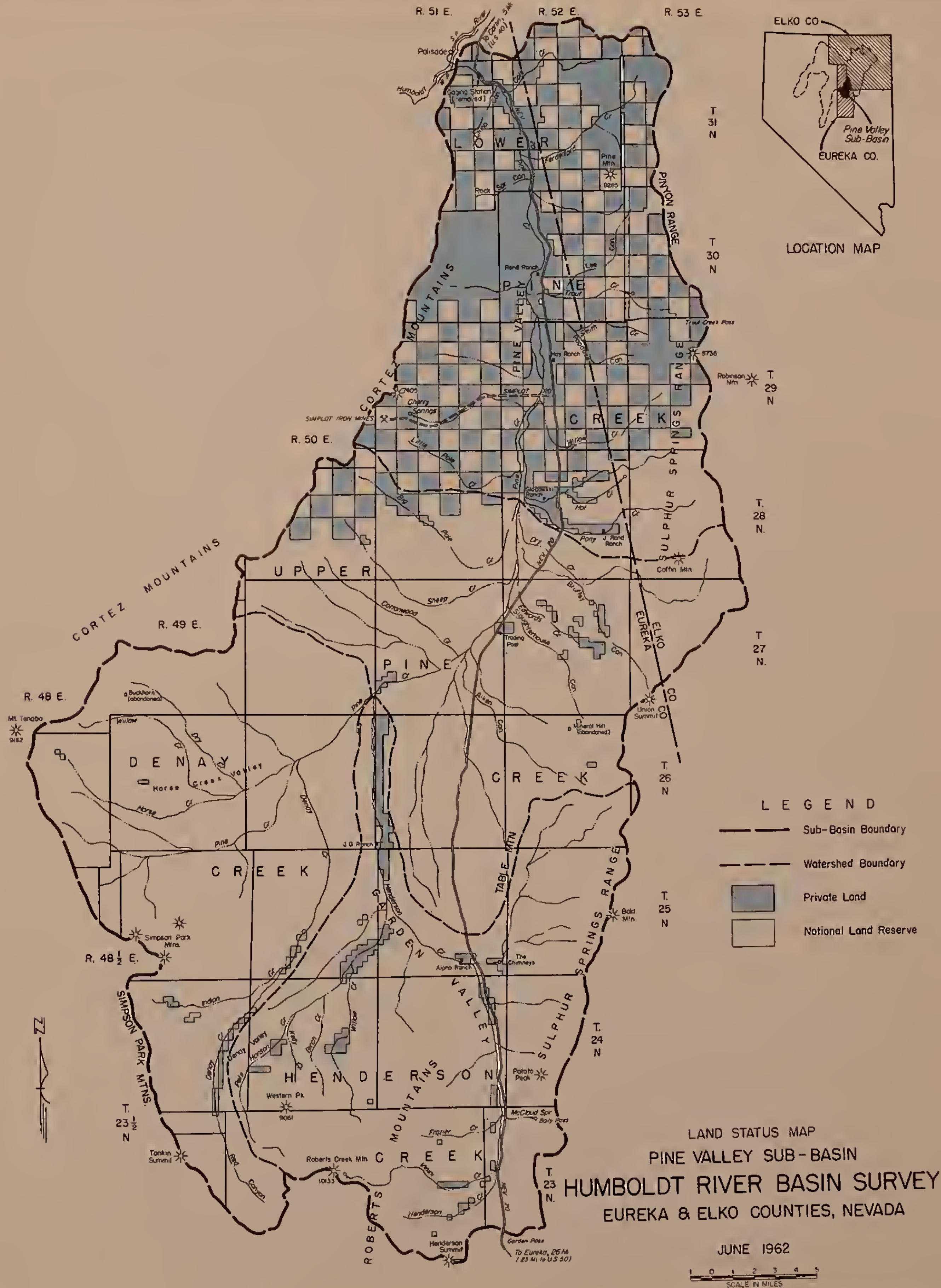
HUMBOLDT RIVER BASIN SURVEY

EUREKA & ELKO COUNTIES, NEVADA

JUNE 1962

1 0 1 2 3 4 5
SCALE IN MILES

7-P-17295-N



LAND STATUS MAP

PINE VALLEY SUB-BASIN

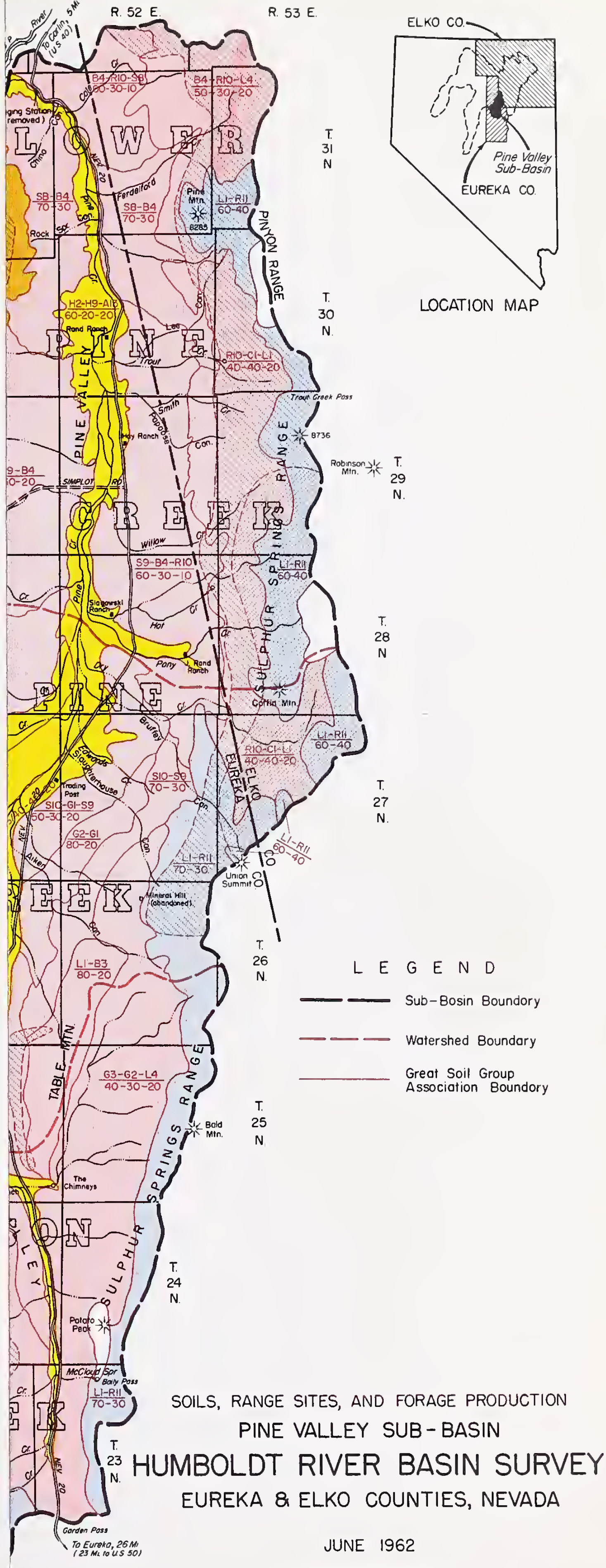
HUMBOLDT RIVER BASIN SURVEY

EUREKA & ELKO COUNTIES, NEVADA

JUNE 1962

7-P-17295-N

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-3719



SOILS, RANGE SITES, AND FORAGE PRODUCTION

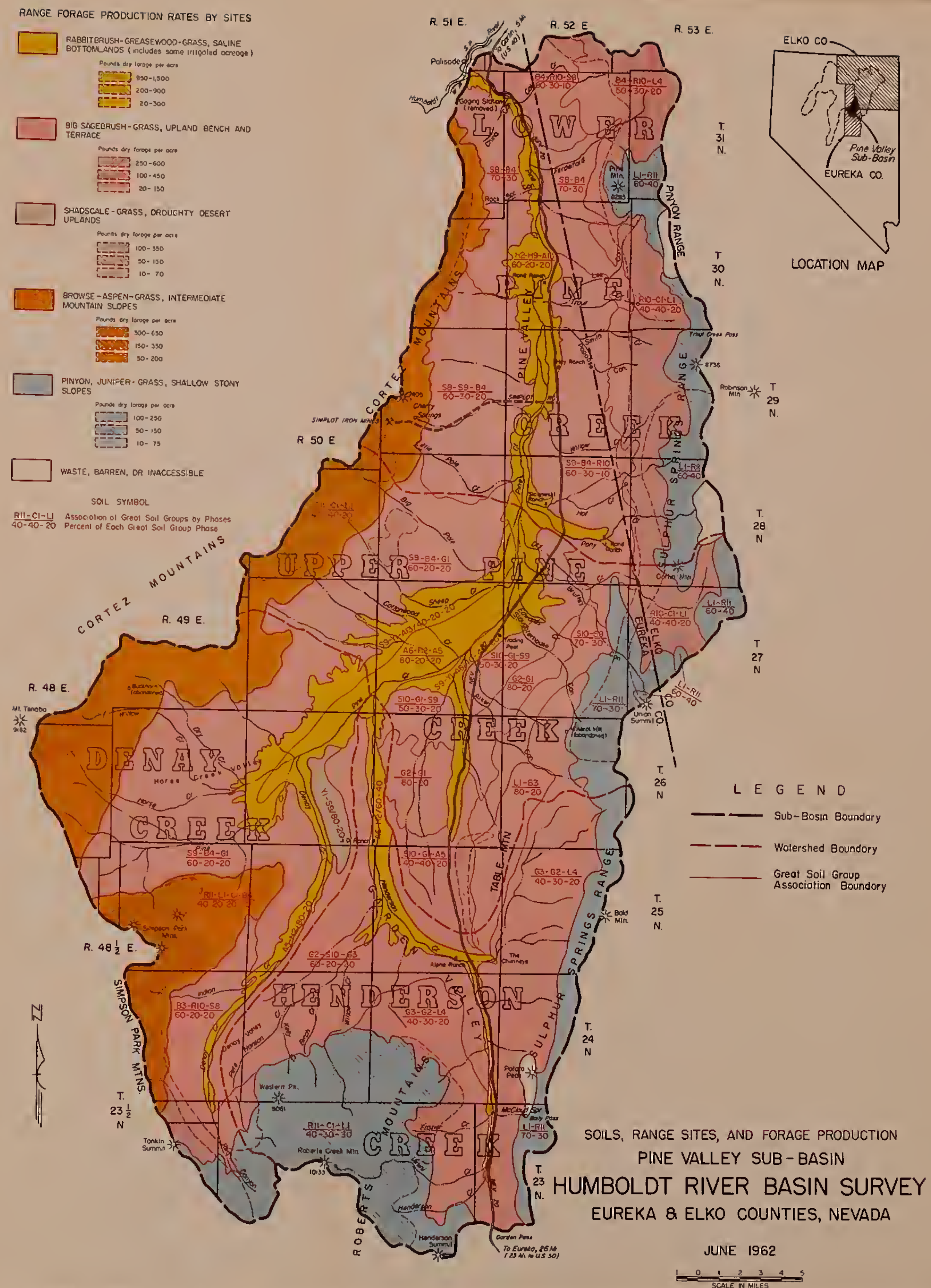
PINE VALLEY SUB-BASIN

HUMBOLDT RIVER BASIN SURVEY

EUREKA & ELKO COUNTIES, NEVADA

JUNE 1962

7-P-17295-N



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LAND USE AND PHREATOPHYTE MAP

PINE VALLEY SUB-BASIN

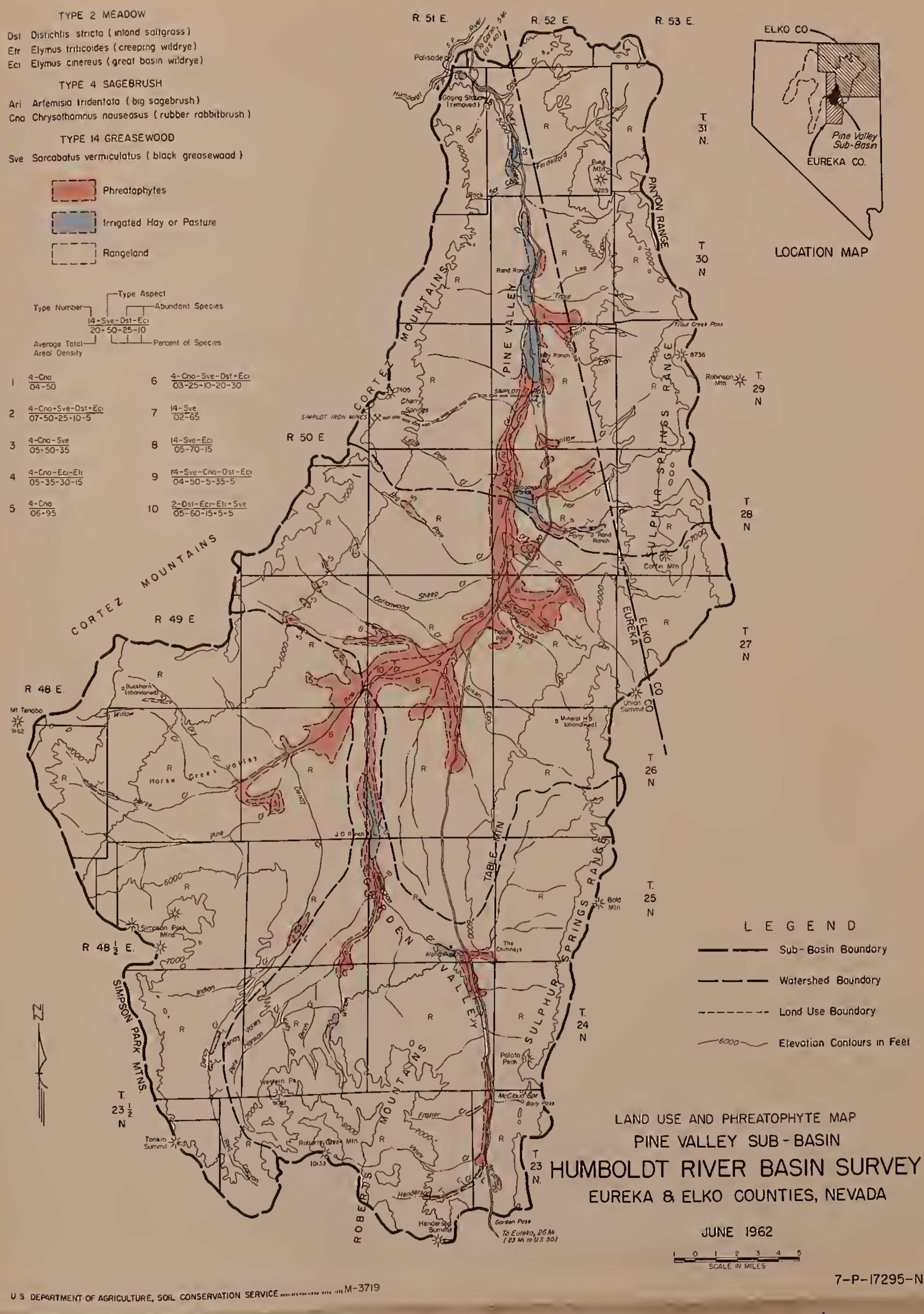
HUMBOLDT RIVER BASIN SURVEY

EUREKA & ELKO COUNTIES, NEVADA

JUNE 1962

SCALE IN MILES

7-P-17295-N


TYPE 2 MEADOW
Dst Distichlis stricta (inland saltgrass)
Etr Elymus triticoides (creeping wildrye)
Eci Elymus cinereus (great basin wildrye)
TYPE 4 SAGEBRUSH
Ari Artemisia tridentata (big sagebrush)
Cna Chrysothamnus nauseosus (rubber rabbitbrush)
TYPE 14 GREASEWOOD
Sve Sarcobatus vermiculatus (black greasewood)
Phreatophytes
Irrigated Hay or Pasture
Rangeland
Type Number
Type Aspect
Abundant Species
14-Sve-Dst-Eci
20-50-25-10
Average Total Areal Density
Percent of Species
1 4-Cna / 04-50
2 4-Cna-Sve-Dst-Eci / 07-50-25-10-5
3 4-Cna-Sve / 05-50-35
4 4-Cna-Eci-Eti / 05-35-30-15
5 4-Cna / 06-95
6 4-Cna-Sve-Dst-Eci / 03-25-10-20-30
7 14-Sve / 02-65
8 14-Sve-Eci / 05-70-15
9 14-Sve-Cna-Dst-Eci / 04-50-5-35-5
10 2-Dst-Eci-Eti-Sve / 05-60-15-5-5
ELKO CO.
Pine Valley Sub-Basin
EUREKA CO.
LOCATION MAP
R. 51 E.
R. 52 E
R. 53 E.
R 50 E
R 49 E
R 48 E.
R 48 1/2 E.
T. 31 N.
T 30 N
T. 29 N
T 28 N
T 27 N
T 26 N
T. 25 N
T. 24 N
T. 23 1/2 N
T. 23 N.
CORTEZ MOUNTAINS
PINE VALLEY
PINYON RANGE
SULPHUR SPRINGS RANGE
TABLE MTN
GARDEN VALLEY
ROBERTS MOUNTAINS
SIMPSON PARK MTNS.
EUREKA ELKO CO
Palisade
Gaging Station (removed)
Pine Mtn
Rand Ranch
Trout Creek Pass
Robinson Mtn
SIMPLOT IRON MINES
Cherry Springs
Coffin Mtn
Union Summit
Mineral Hill (abandoned)
Mt Tenabo 9162
Buckhorn (abandoned)
Horse Creek Valley
J D Ranch
Bald Mtn
Simpson Park Mtns
Alpha
The Chimneys
Tonkin Summit
Western Pk
Roberts Creek Mtn 10133
Henderson Summit
Garden Pass
To Eureka, 26 Mi (23 Mi to U S 50)
Palota Peak
McCloud
LEGEND
Sub-Basin Boundary
Watershed Boundary
Land Use Boundary
6000 Elevation Contours in Feet
LAND USE AND PHREATOPHYTE MAP
PINE VALLEY SUB-BASIN
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